Game Plan

Lecture

- Epidemiology
- Disease terminology
- Classification of infectious disease
- Development of disease
- Case studies: flu and ebola
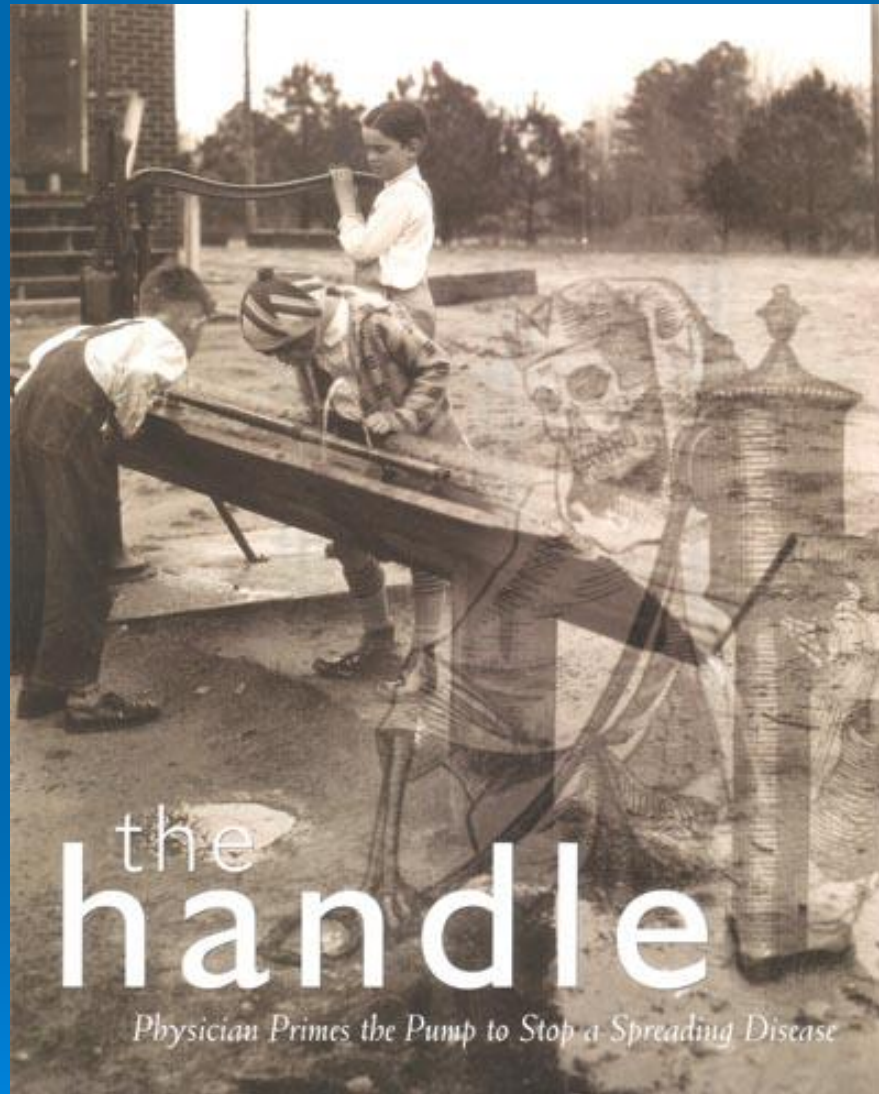
Lab

Continue Minor Unknown

The origins of modern epidemiology

John Snow
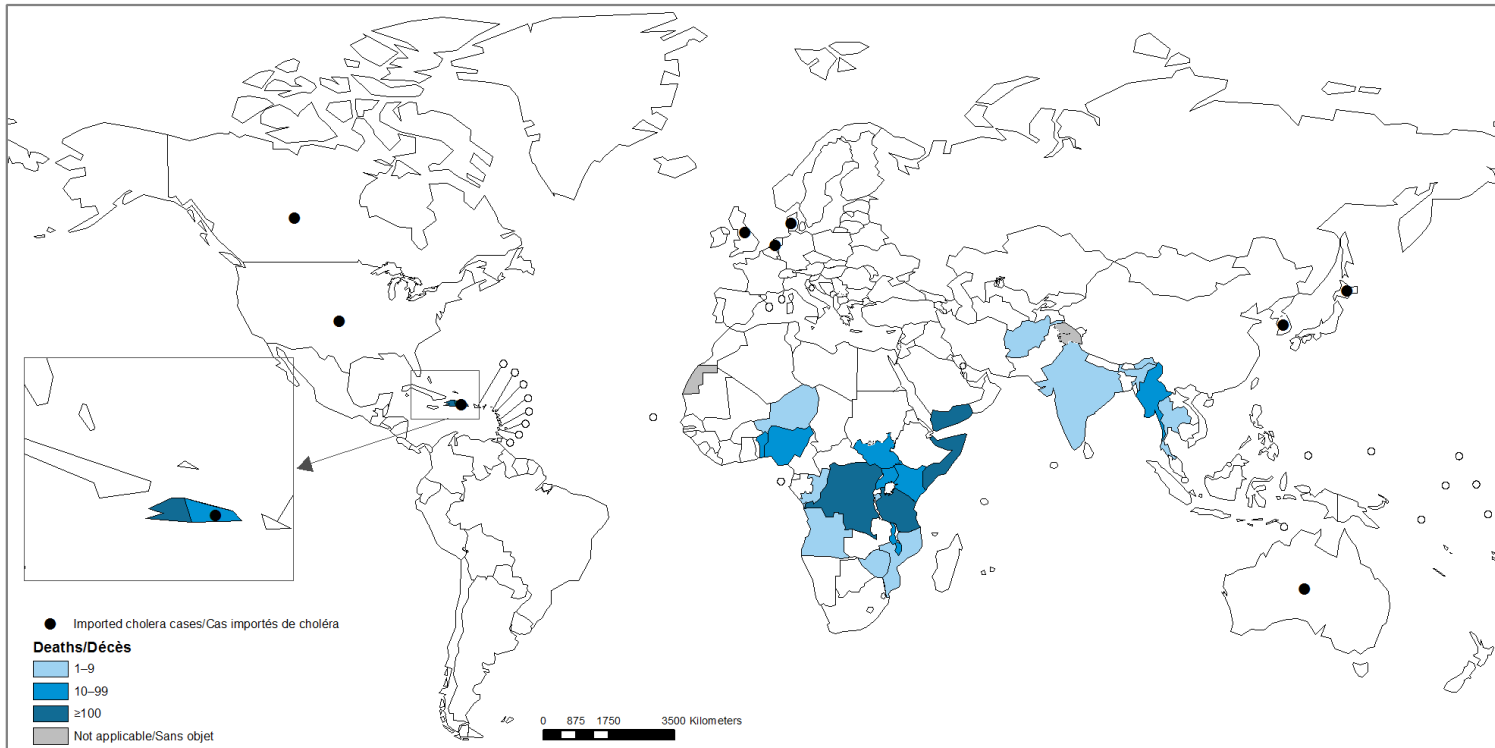Cholera epidemic in
London

The origins of modern epidemiology

the
handle

Physician Primes the Pump to Stop a Spreading Disease

UCLA dedicated site to the life and history of Snow:

http://www.ph.ucla.edu/epi/snow.html

Cholera continues

Countries reporting cholera deaths and imported cases in 2016
Pays ayant déclaré des décès dus au choléra et des cas importés en 2016

The origins of modern epidemiology

John Snow
Cholera epidemic in London

Ignaz Semmelweis
Puerperal fever in hospitals

The origins of modern epidemiology
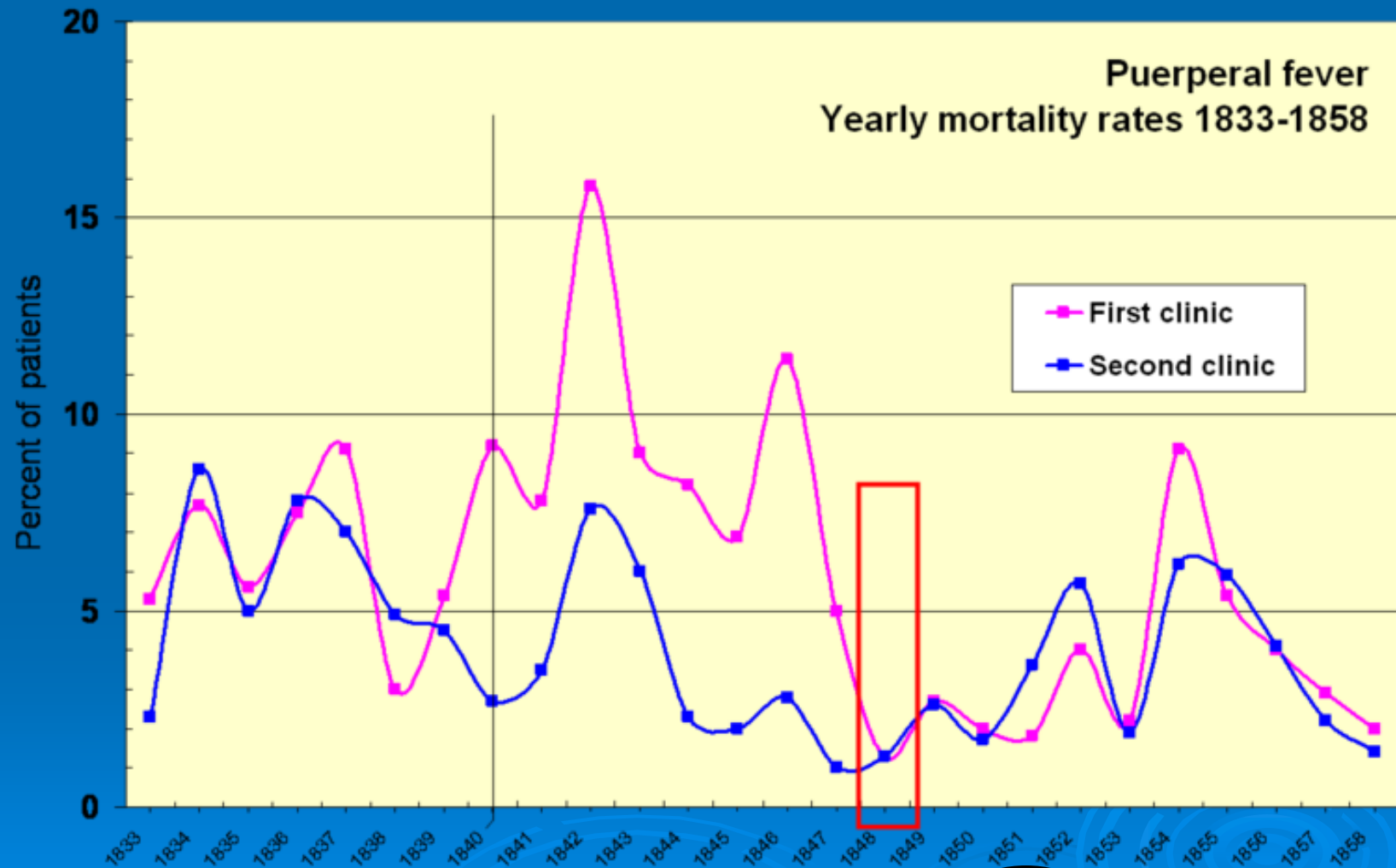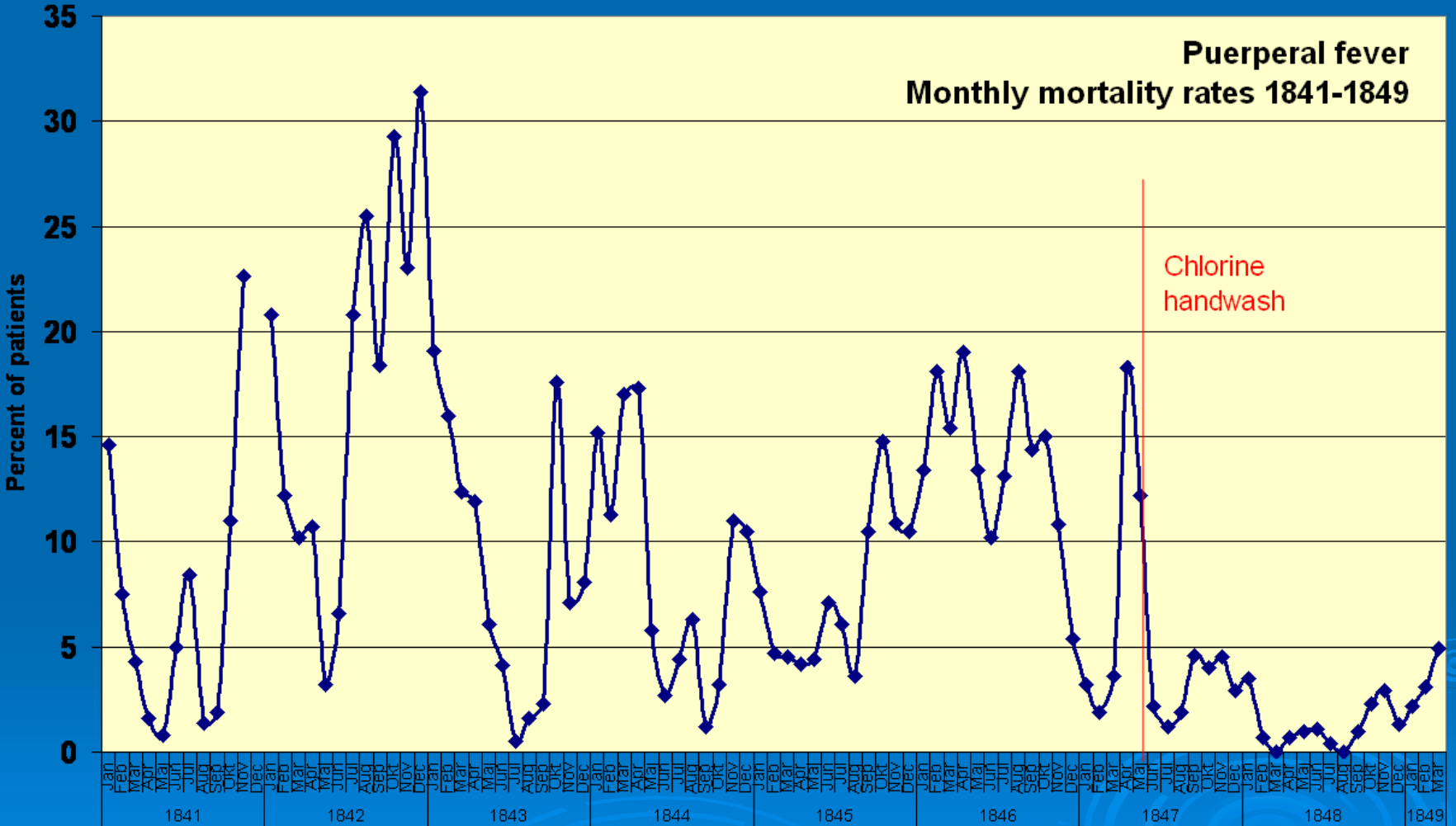
Puerperal fever
Yearly mortality rates 1833-1858

First clinic
Second clinic

The origins of modern epidemiology

Puerperal fever
Monthly mortality rates 1841-1849

Chlorine handwash

The origins of modern epidemiology

John Snow
Cholera epidemic in London
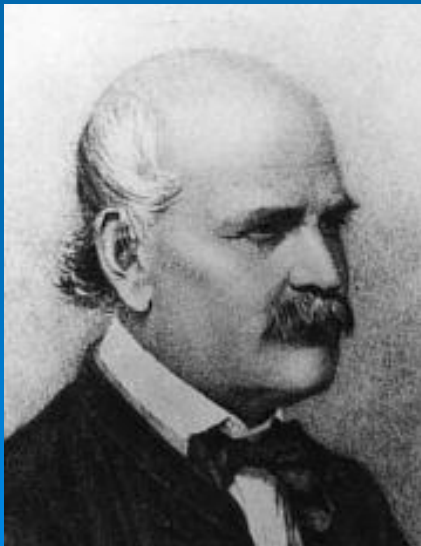
Ignaz Semmelweis
Puerperal fever in hospitals
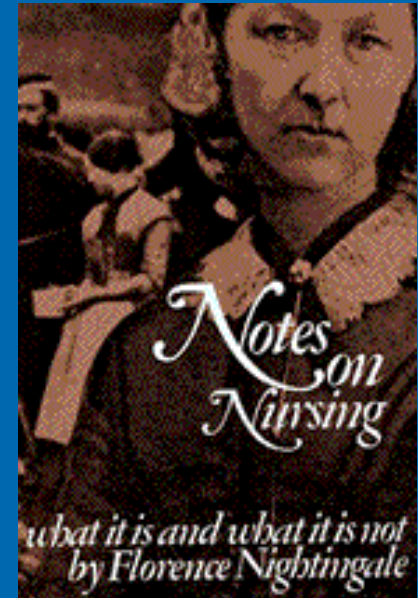
Florence Nightingale
Death rates of Crimean War soldiers

Terminology

Disease- in a state of not being healthy, change from health

Infection- colonization or invasion of pathogens, may be microbes in the wrong place

Pathogens- disease causing organisms

Etiology- study of the cause of a disease

Case Study 1: Influenza

Influenza Type A - the most common and causes the most serious seasonal epidemics and pandemics infecting multiple species (people, birds, pigs, horses, cats...)

Influenza Type B - can cause seasonal epidemics, but the disease is less severe; generally infecting only humans

Influenza Type C - not connected with epidemics or pandemics; more mild symptoms infecting humans and swine

Influenza virus

Nucleoprotein (RNA)

Influenza Virus Anatomy

Neuraminidase (Sialidase)

Lipid Envelope

Figure 1

Capsid
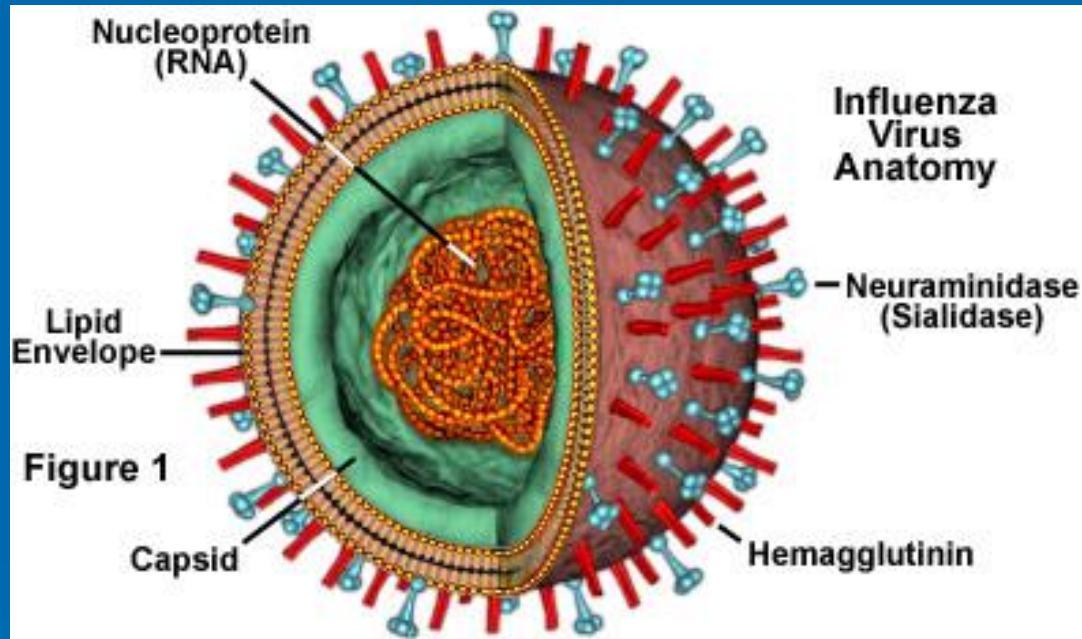
Hemagglutinin

Key features

-Orthomyxovirus (viral family)

-RNA virus, surrounded by capsid and envelope

-Envelope molecules
-Hemagglutinin (HA)
-Neuraminidase (N)

Influenza surface glycoproteins

Hemagglutinin (HA)

Binds to sialic acid residues on glycosylated receptor proteins of host
Fuses viral membrane to host cell (endosome) membrane
FUNCTION: releases viral RNA into cell

16 subtypes of HA

**__Antigenic Drift__: Changes in 4 active sites in each subtype create diversity- allows for seasonal flu

Neuraminidase (N)

Cleaves sialic acid from host glycoproteins
FUNCTION: allows virus to enter/ leave cell

9 subtypes of N

The "bird flu"-
A case study in epidemiology

Seasonal flu- influenza virus (A or B) that causes respiratory illness; transferred from person to person; vaccines available, some immunity

Avian or bird flu (AI)- influenza (A) virus that infects wild birds can be transmitted from bird to human, no vaccine, no immunity

Pandemic flu- human influenza (A) virus on a global level, spread from human to human, no immunity

Recent Influenza A infections

<u>Human infections with human influenza viruses</u>

H1N1
H1N2
H3N2

CDC: The 2018-2019 trivalent influenza vaccine is made from the hemagglutinin of the following three viruses:

- A/Michigan/45/2015 (H1N1)pdm09–like virus
- A/Singapore/INFIMH-16-0019/2016 (H3N2)-like virus*
- B/Colorado/06/2017–like virus (Victoria lineage)*

- The CDC also recommended a quadrivalent vaccine containing a B/Phuket/3073/2013–like virus (Yamagata lineage)

<u>WHY VACCINATE?...</u>

HERD IMMUNITY
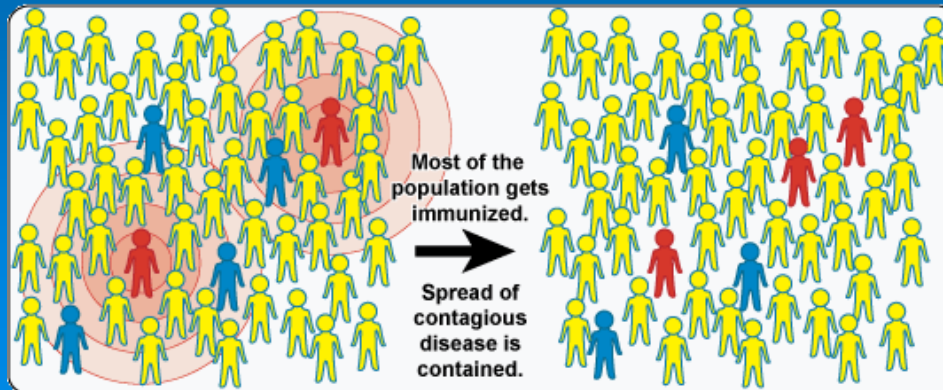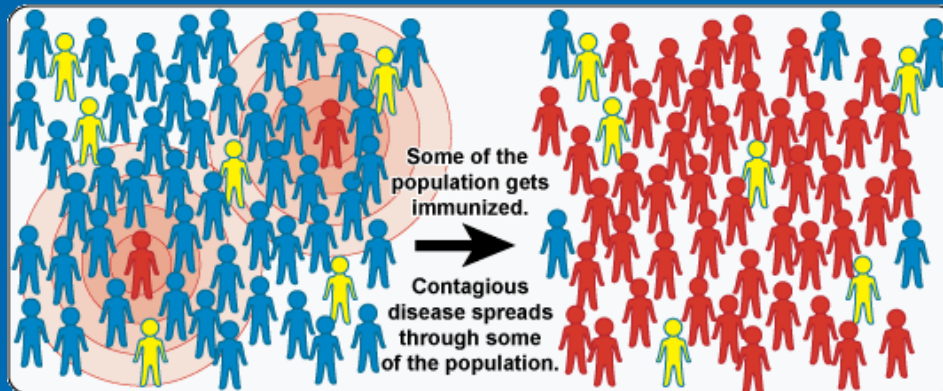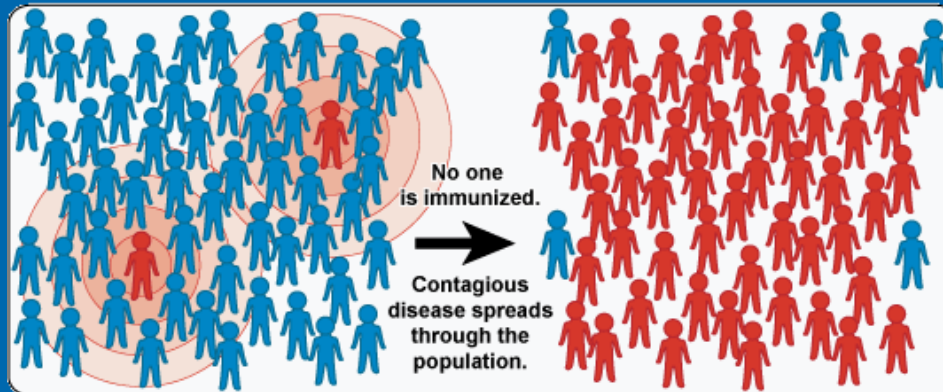
HERD IMMUNITY
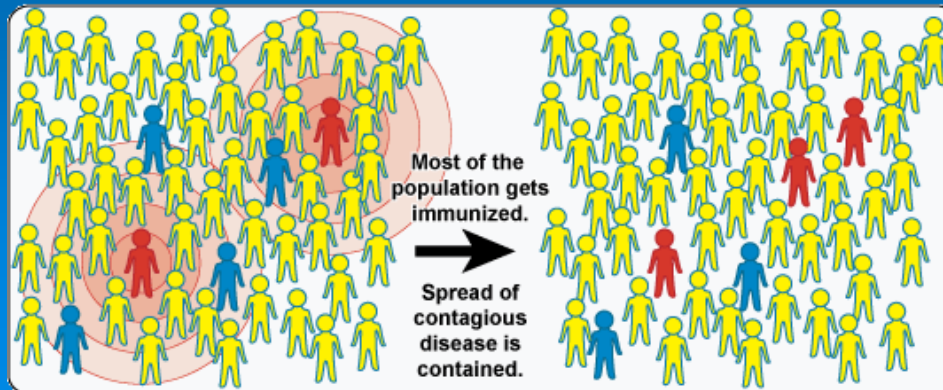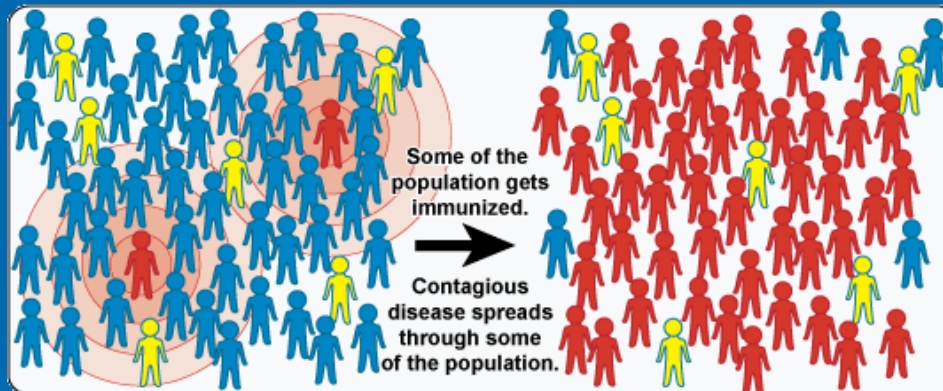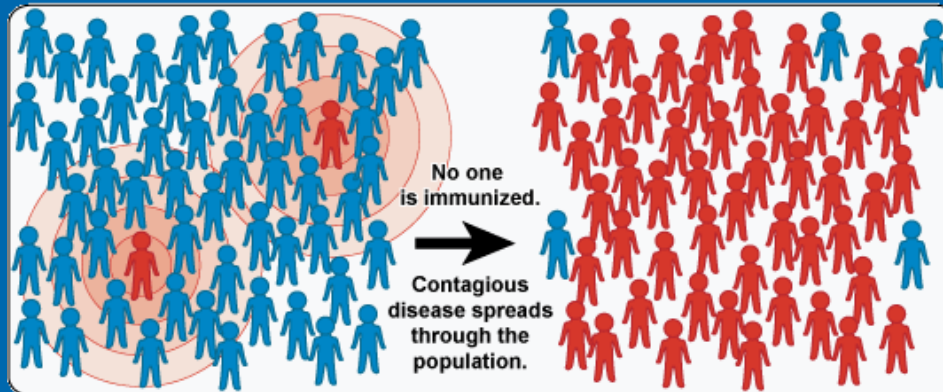
2018-2019 US Flu Activity

2018-19 Influenza Season Week 40 ending Oct 06, 2018
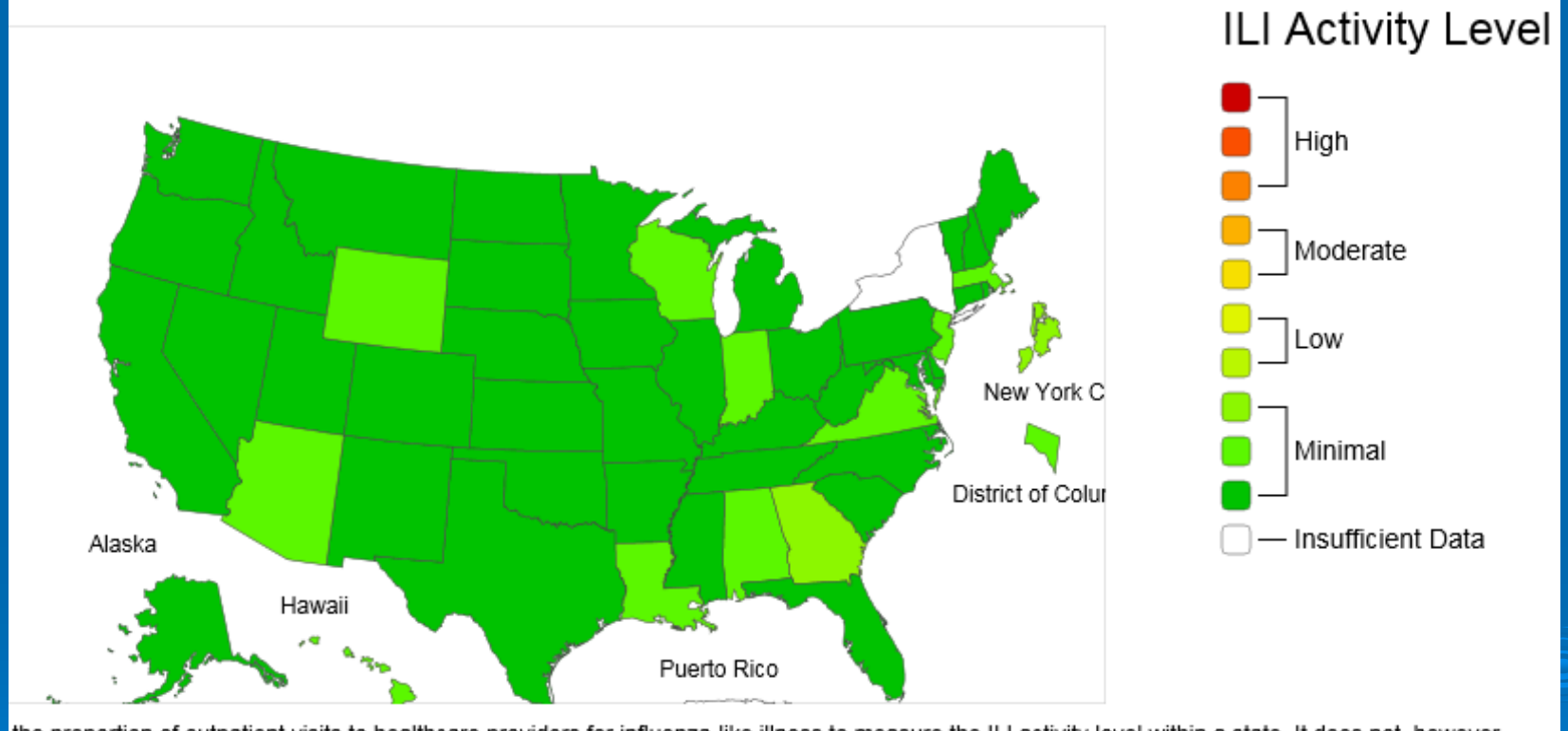
ILI Activity Level

High
Moderate
Low
Minimal
Insufficient Data

2018-2019 US Flu Activity

2018-19 Influenza Season Week 12 ending Mar 23, 2019
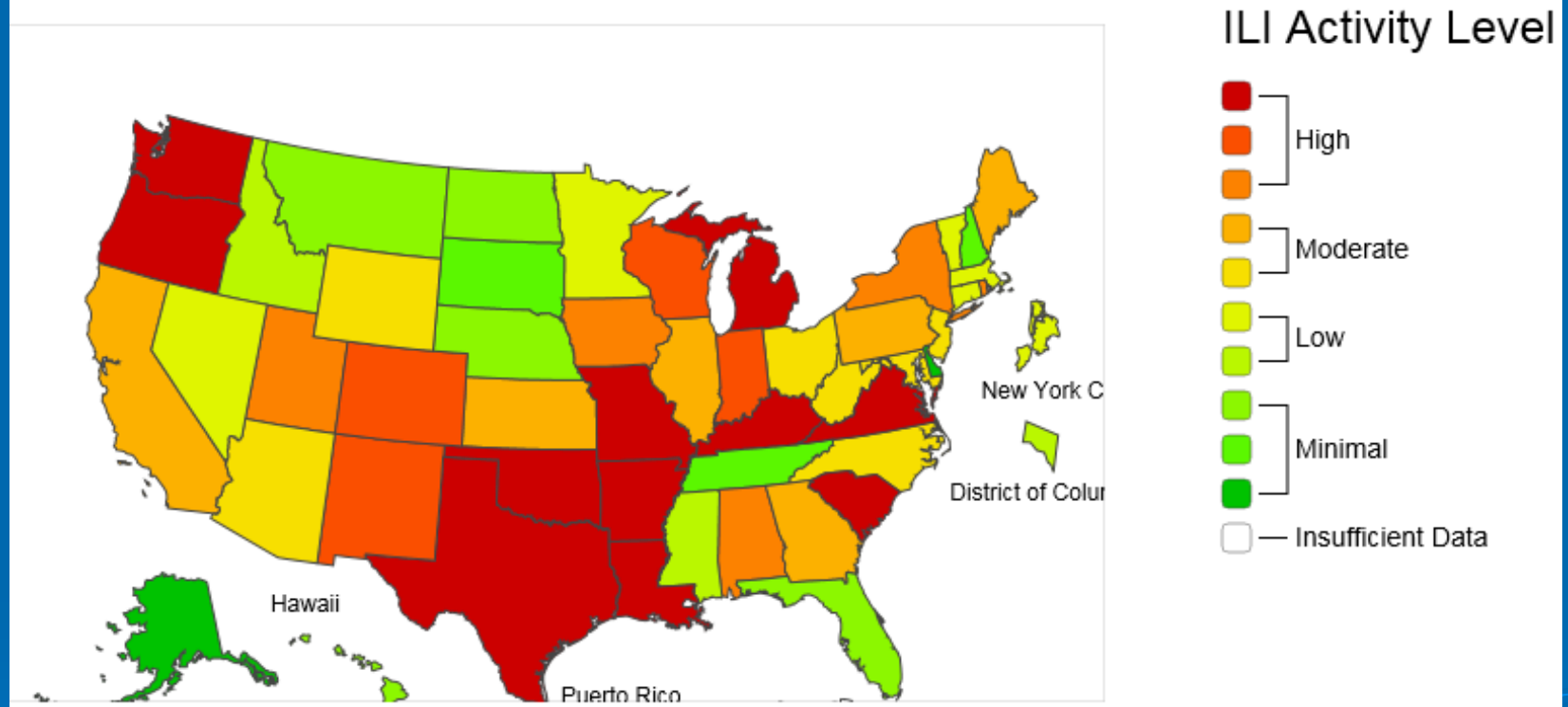
2018-2019 flu by genotypes

Influenza Positive Specimens Reported by U.S. Public Health Laboratories, Cumulative, 2018-2019 Season
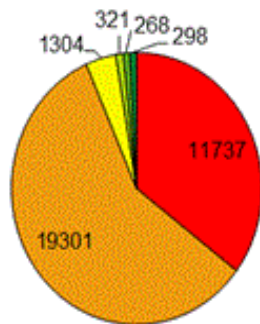
Sequence Results, by Genetic HA Clade/Subclade, of Specimens Submitted to CDC by U.S. Public Health Laboratories, Cumulative, 2018-2019 Season
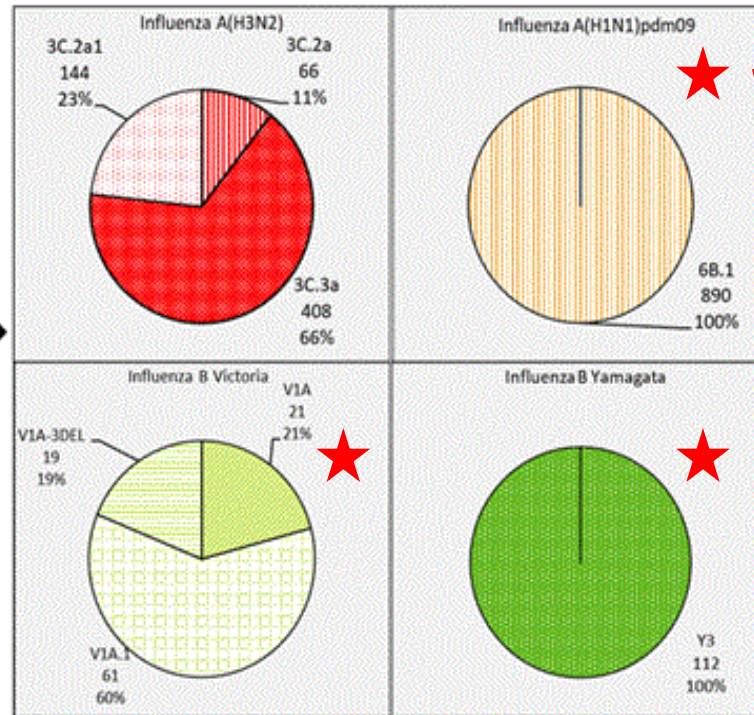
2018-2019 flu by genotypes

Avian flu

Cumulative number of confirmed human cases for avian influenza A(H5N1) reported to WHO, 2003-2018

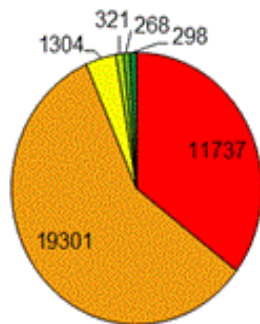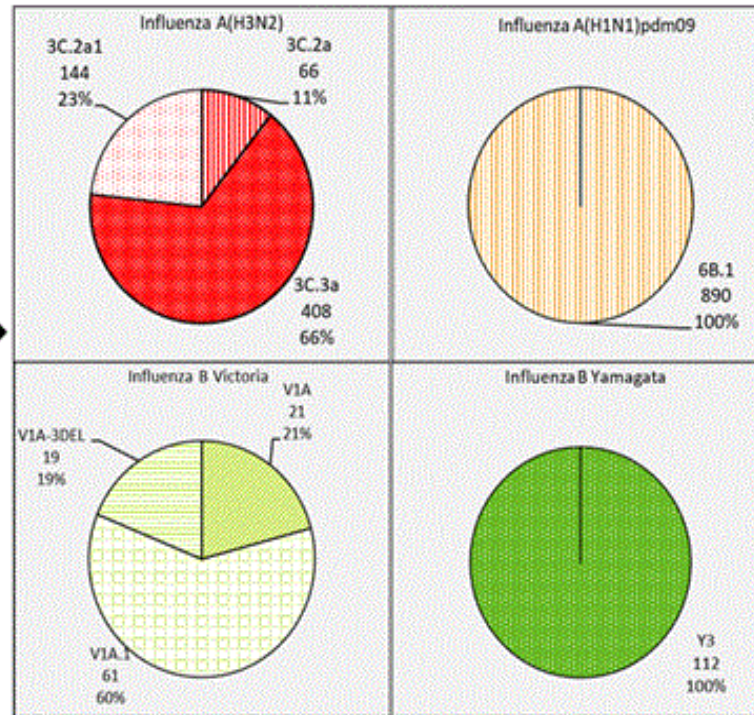| Country	2003-2009*		2010-2014**		2015		2016		2017		2018		Total	
	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths
Azerbaijan	8	5	0	0	0	0	0	0	0	0	0		8	5
Bangladesh	1	0	6	1	1	0	0	0	0	0	0		8	1
Cambodia	9	7	47	30	0	0	0	0	0	0	0		56	37
Canada	0	0	1	1	0	0	0	0	0	0	0		1	1
China	38	25	9	5	6	1	0	0	0	0	0		53	31
Djibouti	1	0	0	0	0	0	0	0	0	0	0		1	0
Egypt	90	27	120	50	136	39	10	3	3	1	0		359	120
Indonesia	162	134	35	31	2	2	0	0	1	1	0		200	168
Iraq	3	2	0	0	0	0	0	0	0	0	0		3	2
Lao People's Democratic Republic	2	2	0	0	0	0	0	0	0	0	0		2	2
Myanmar	1	0	0	0	0	0	0	0	0	0	0		1	0
Nigeria	1	1	0	0	0	0	0	0	0	0	0		1	1
Pakistan	3	1	0	0	0	0	0	0	0	0	0		3	1
Thailand	25	17	0	0	0	0	0	0	0	0	0		25	17
Turkey	12	4	0	0	0	0	0	0	0	0	0		12	4
Viet Nam	112	57	15	7	0	0	0	0	0	0	0		127	64
Total	468	282	233	125	145	42	10	3	4	2	0	0	860	454

* 2003-2009 total figures. Breakdowns by year available on subsequent tables.
** 2010-2014 total figures. Breakdowns by year available on subsequent tables.

Total number of cases includes number of deaths.
WHO reports only laboratory cases.
All dates refer to onset of illness.

Source: WHO/GIP, data in HQ as of 2 March 2018

World Health Organization

Flu pandemics

Pandemics Death Toll Since 1900

1918-1919: The Spanish Flu

U.S….	675,000+
Worldwide…	50,000,000+

1957-1958: The Asian Flu

U.S….	70,000+
Worldwide….	1-2,000,000

1968-1969: The Hong Kong Flu

U.S….	34,000+
Worldwide…	700,000+

2009-2010 Swine Flu

U.S…..	13,000+
Worldwide…	200,000+

www.cdc.gov

How would a pandemic flu arise?

Animation of antigenic drift, shift and pandemics
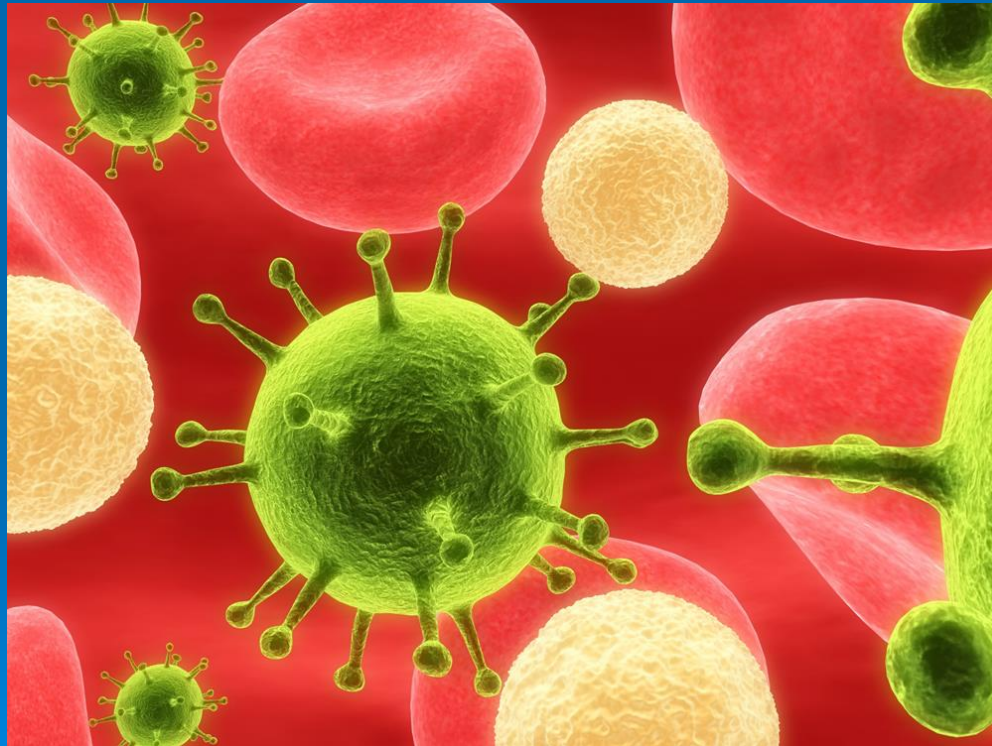
Antigenic shift: the source of pandemic flu

Avian virus (H7N7) transmitted to pig

Human (H₃N₃) virus transmitted to pig

Bird

Pig

Human

Wild bird infected with H7N7

Pig infected with H1N1

Human infected with H3N2

H spike

N spike

Gene segments

Avian virus

Pig virus

Human virus

Pig infected with H1N1, H3N2, H7N7

New virus transmitted to human

Genetic exchange produces a new virus
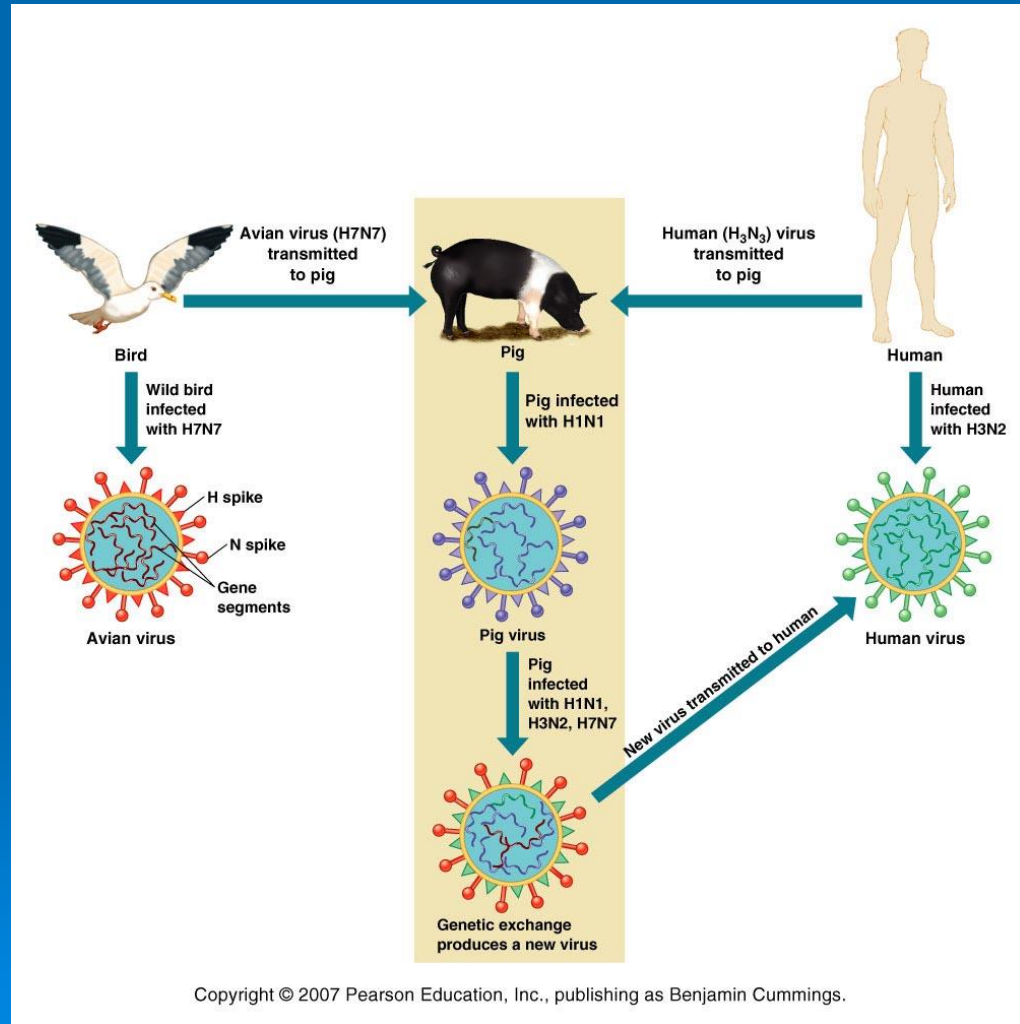
Case study 2: Ebola
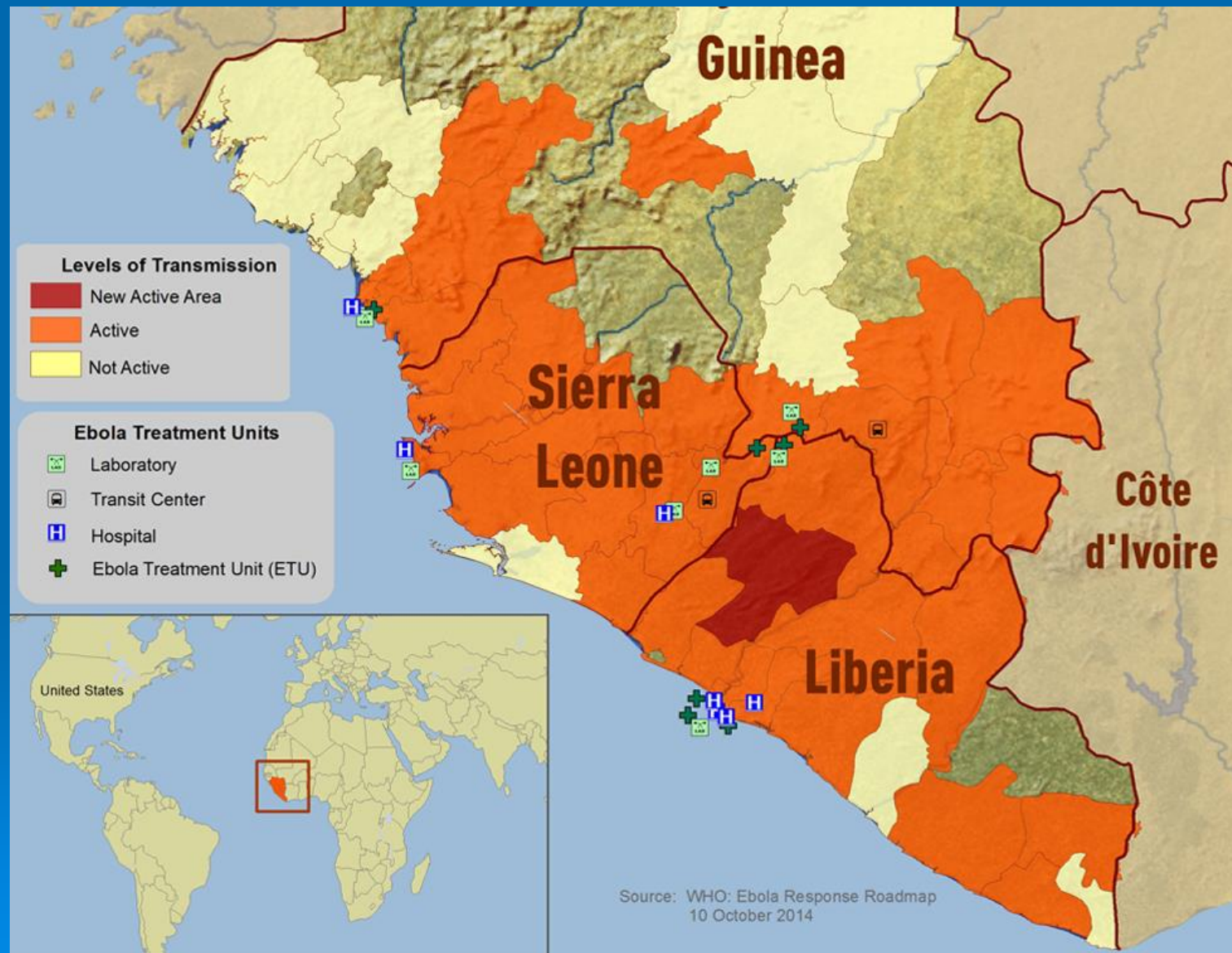
Ebola virus

- Family Filoviridae

- **Negative sense RNA** virus with **capsid** and **envelope**

- Cylindrical/ helical

Ebola sub-types

- Ebola virus disease is cause by four of five viruses in the genus Ebolavirus:

  - Bundibugyo virus (BDBV)

  - Sudan virus (SUDV)

  - Taï Forest virus (TAFV)

  - Ebola virus (EBOV, formerly Zaire Ebola virus)

History of Ebola outbreaks

EBOLAVIRUS OUTBREAKS BY SPECIES AND SIZE, 1976 - 2014

Species

- Zaire ebolavirus
- Sudan ebolavirus
- Tai Forest ebolavirus
- Bundibugyo ebolavirus

Number of Cases

- 1 - 10
- 11 - 100
- 101 - 300
- Greater than 300 reported cases

E. Ervin, CDC/VSPB, 2014

2014 outbreak totals (as of 10/14/14)
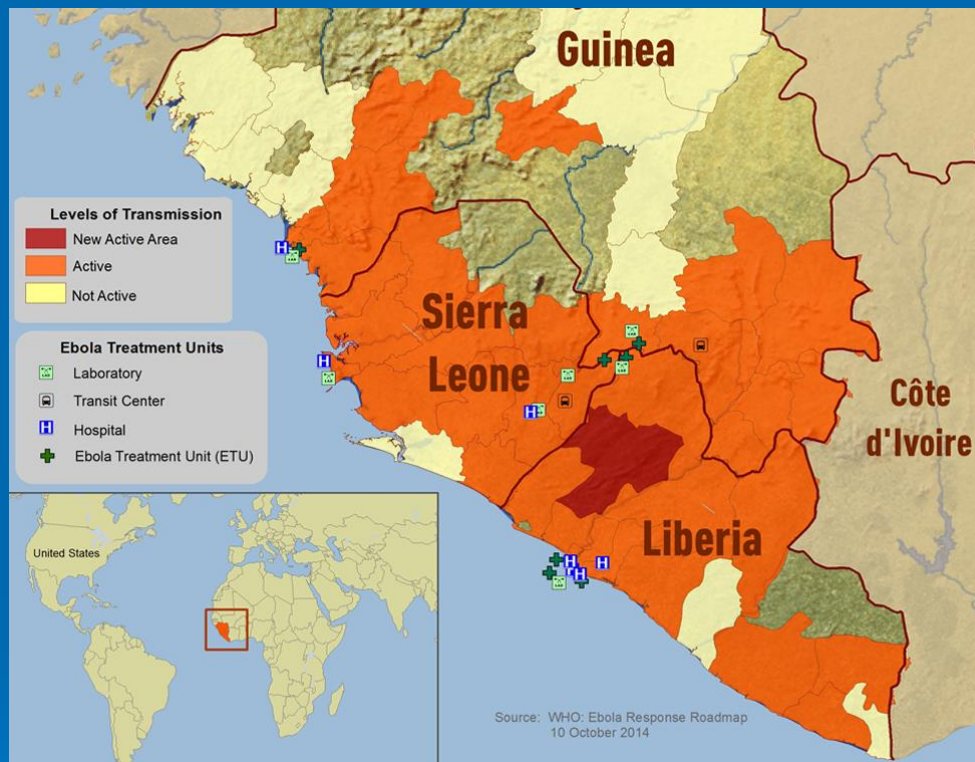
Location	Total	Deaths
Guinea	1519	862
Liberia	4249*	2484*
Sierra Leone	3410	1200
Senegal	1	0
Spain	1	0
Nigeria	20	8
US	3	1
Democratic Republic of the Congo (unrelated to ongoing West African Outbreak)	68	49
TOTALS:	9271	4604 (50%)

Levels of Transmission
- New Active Area
- Active
- Not Active

Ebola Treatment Units
- Laboratory
- Transit Center
- Hospital
- Ebola Treatment Unit (ETU)

Source: WHO: Ebola Response Roadmap
10 October 2014

What is contact tracing?
Contact tracing can stop an Ebola outbreak in its tracks

CDC

U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

Contact tracing is finding everyone who comes in direct contact with a sick Ebola patient. Contacts are watched for signs of illness for 21 days from the last day they came in contact with the Ebola patient. If the contact develops a fever or other Ebola symptoms, they are immediately isolated, tested, provided care, and the cycle starts again—all of the new patient's contacts are found and watched for 21 days. **Even one missed contact can keep the outbreak going.**

EBOLA PATIENT
Isolate & Provide Care

Ask about contacts

21 days Watch contacts for symptoms of sickness for 21 days

If contact shows symptoms isolate, test, and provide care

EBOLA PATIENT
Isolate & Provide Care

Ask about contacts

21 days Watch contacts for symptoms of sickness for 21 days

Repeat cycle until no new patients If

21 days contact shows no symptoms after 21 days

Contact not at risk of developing Ebola

? Missed contact

? ? ? May spread Ebola to new contacts

Contact tracing finds new cases quickly so they can be isolated to stop further spread.

If contact shows symptoms isolate, test, and provide care

EBOLA PATIENT
Isolate & Provide Care

Ask about contacts

If no contacts, no further spread

How does one characterize a disease?

Symptom: a change in body function that is felt by a patient (achy, tired, sore throat...)

Sign: a change in body that can be measured or observed (fever, rash, inflammation...)

Syndrome: a specific group of signs and symptoms

How does one characterize a disease?

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Syndrome: a specific group of signs and symptoms

Flu syndrome: ranges from respiratory illness, muscle aches, high fever, head ache, chills, fatigue, dry cough and runny/stuffy nose, acute pneumonia, severe diarrhea, encephalitis…

Ebola syndrome: characterized by fever, severe headache, muscle pain, weakness, diarrhea, vomiting, abdominal (stomach) pain, unexplained hemorrhage (bleeding or bruising)

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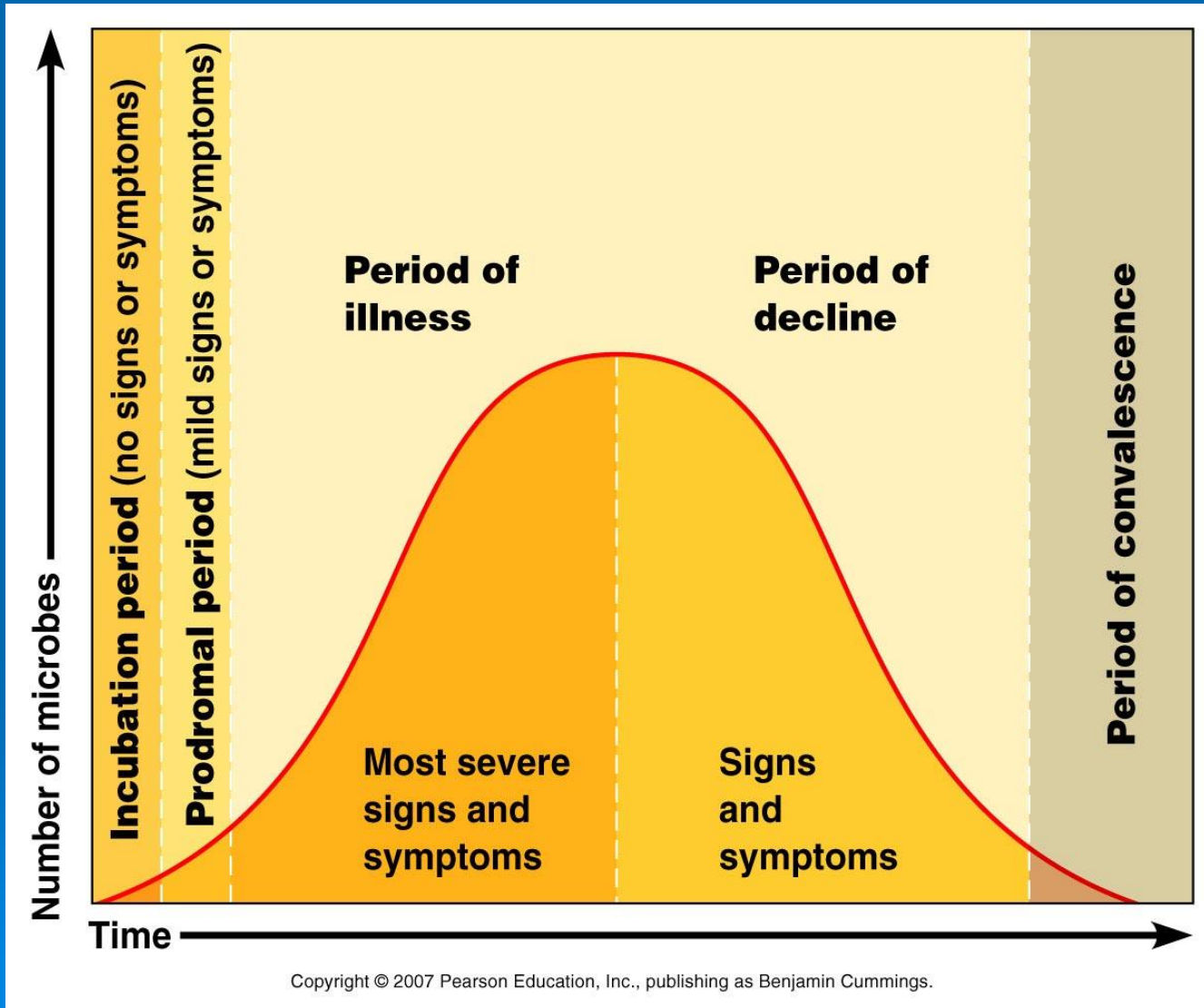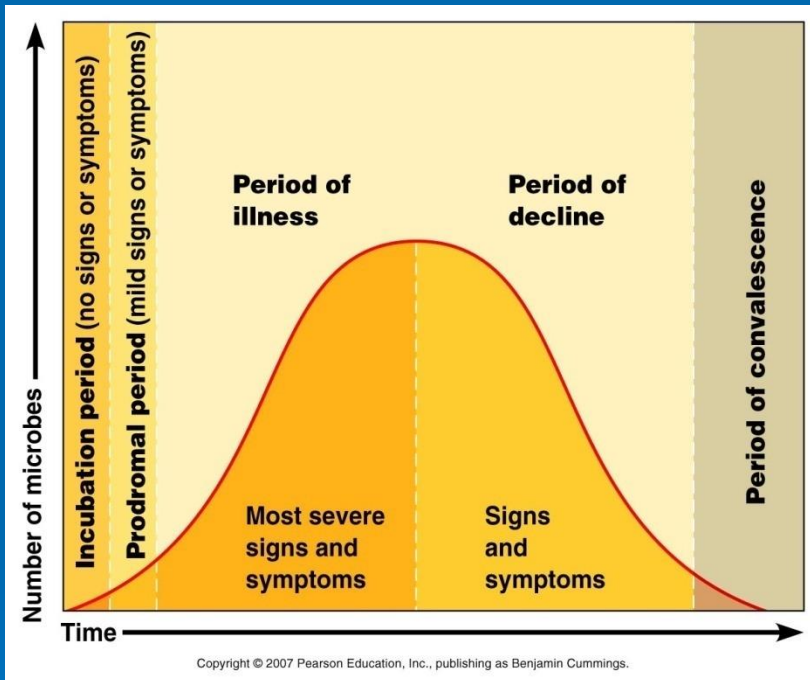
Stages of a disease

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Figure 14.5

Disease treatment and prevention

Number of microbes (y-axis)

Incubation period (no signs or symptoms) | Prodromal period (mild signs or symptoms)

Period of illness

Period of decline

Period of convalescence

Most severe signs and symptoms

Signs and symptoms

Time

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Pre-illness period (flu):

Vaccines
(seasonal vaccines; pandemic vaccine would be 1 year out)

Pre-illness period (ebola):

Vaccine
VSV-EBOV

Disease treatment and prevention

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Post-infection (flu):
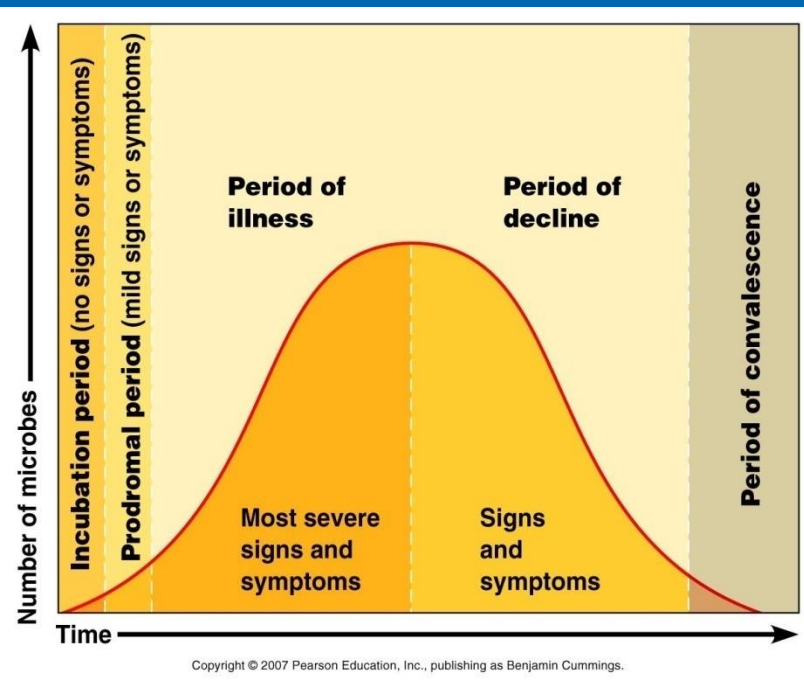
➢ **Neuraminidase inhibitors:**
Tamiflu (oseltamivir), Relenza (zanamivir), Rapivab (peramivir)

➢ **Inhibition of viral attachment:**
Fludase (Ph II)
ParaDase (Ph II)

➢ **Antisense DNA interference:**
Neugene (Pre)

www.Pandemicflu.gov
www.Avianflu.gov

Post-infection (ebola):

➢ **Nucleotide analog:**
Brincidofovir (currently under development against all 5 DNA viral families against humans)

➢ **Antisense DNA interference:**
Neugene (Pre)

www.chimerix.com

➢ **Supportive care:**

➢ Providing intravenous fluids (IV)and balancing electrolytes (body salts)

➢Maintaining oxygen status and blood pressure

➢Treating other infections if they occur

Disease treatment and prevention
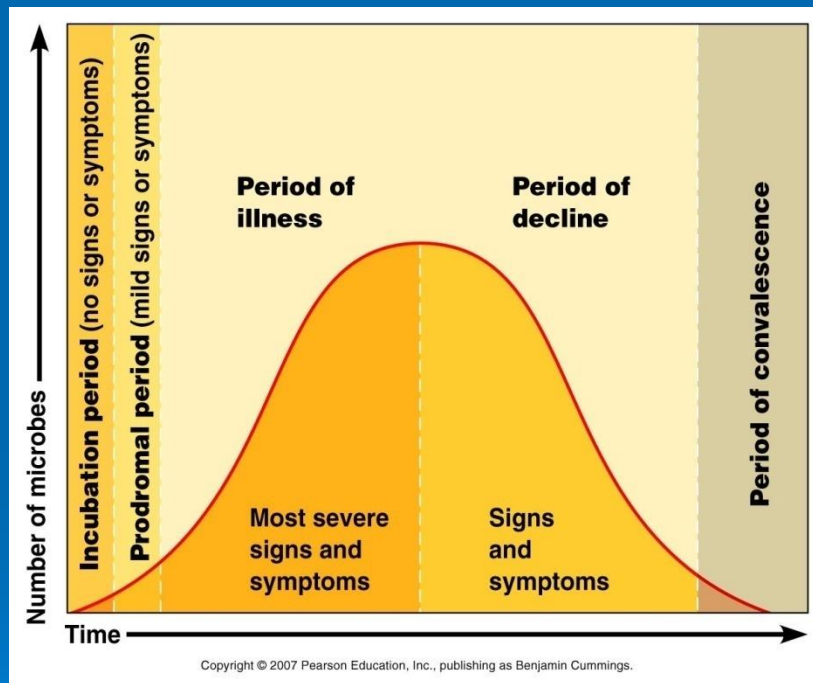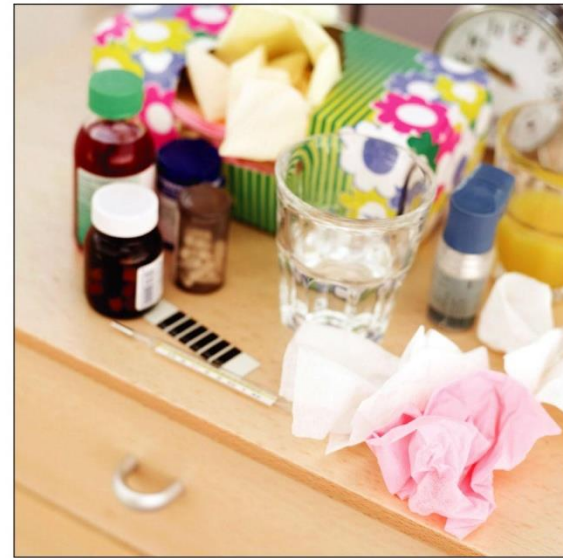

All periods:

Prevent disease transmission!

Contact transmission

(a)

Direct

(c)

Indirect

(d)

Droplet

Figure 14.6 - Overview

Vehicle transmission

(a)

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(b)

Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 14.7 - Overview

Vector transmission

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Mechanical

Biological

Nosocomial infections
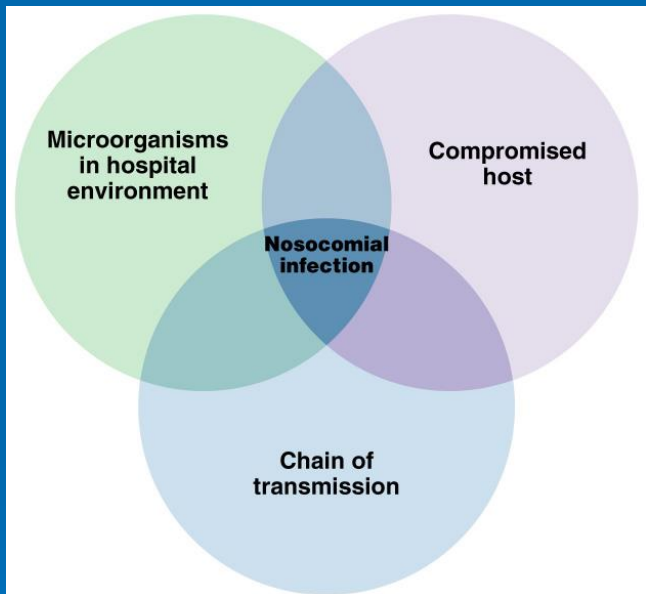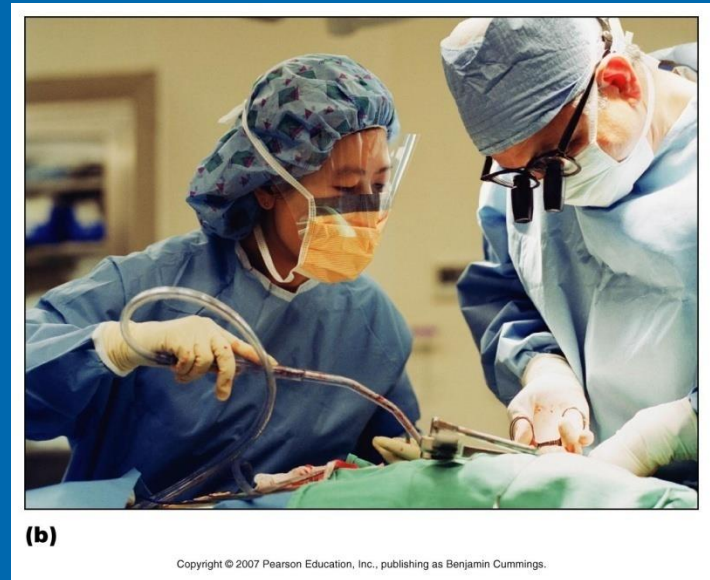

Figure 14.6b

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Figure 14.9

- Urinary tract infections — 40%
- Surgical site infections — 20%
- Lower respiratory infections — 15%
- Bacteremia caused primarily by IV catheterizations — 6%
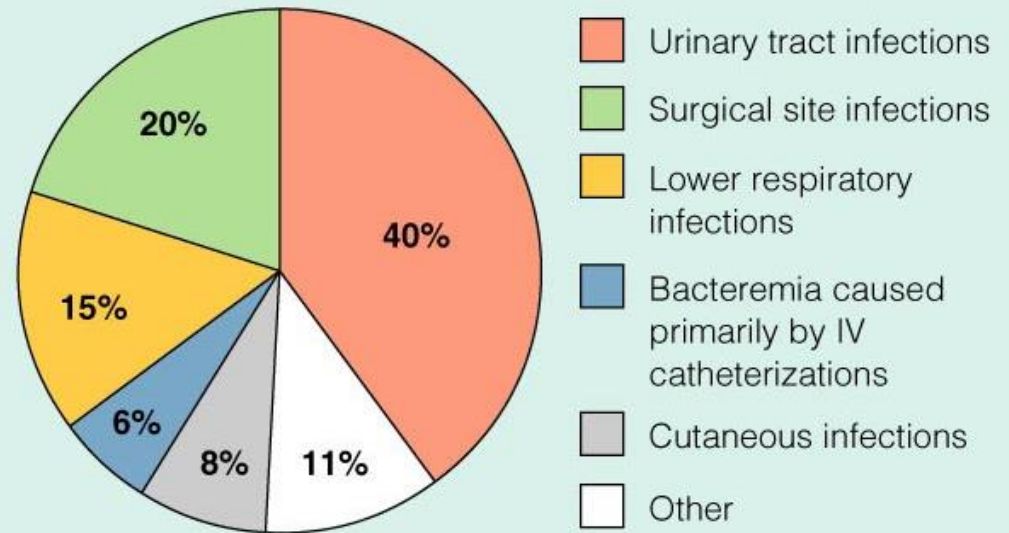- Cutaneous infections — 8%
- Other — 11%

Table 14.5 (2 of 2)

What is the transmission mode for influenza and ebola?

Facts *about* Ebola in the U.S.

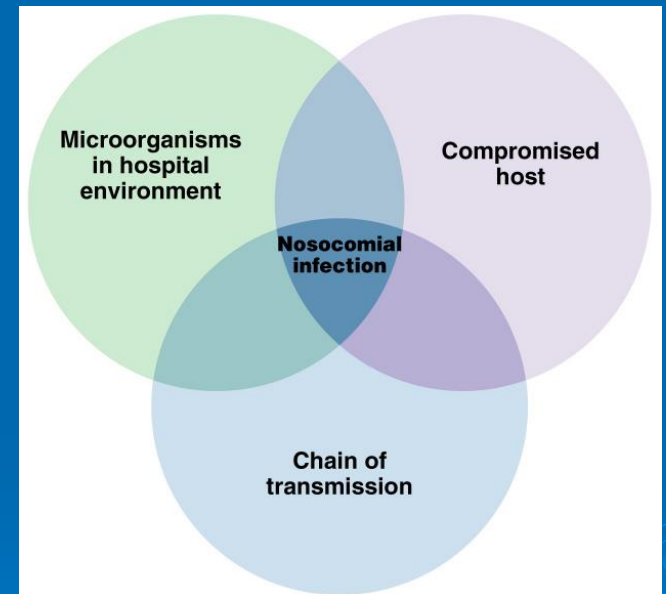You can't get Ebola through air

You can't get Ebola through water

You can't get Ebola through food

Ebola infections in the US

	Community acquired	Nosocomial
Thomas Duncan	√	
Nurse 1		√
Nurse 2		√

Independent study

1. Define the following terms, used to classify a disease by:

    Transmission
    1. Communicable disease
    2. Contagious disease
    3. Noncommunicable disease

    Severity
    1. Acute disease
    2. Chronic disease
    3. Subacute disease
    4. Latent disease

    Host involvement
    1. Local infection
    2. Systemic infection
    3. Primary infection
    4. Secondary infection