Foodborne and Zoonotic Infectious Diseases in the Landscape of Changing Climate

Climate Change and the Global Response: A Multi-Disciplinary Perspective

Vanderbilt School of Engineering

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Additional Resources

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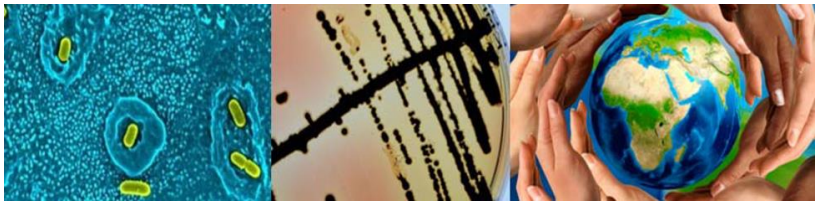

PART I: Overview of Foodborne Pathogens of Public Health Concern

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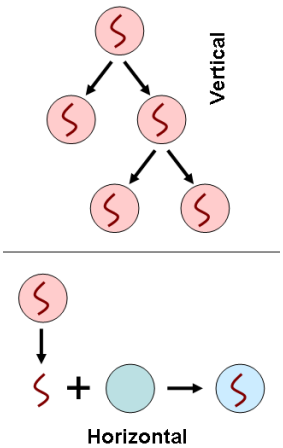
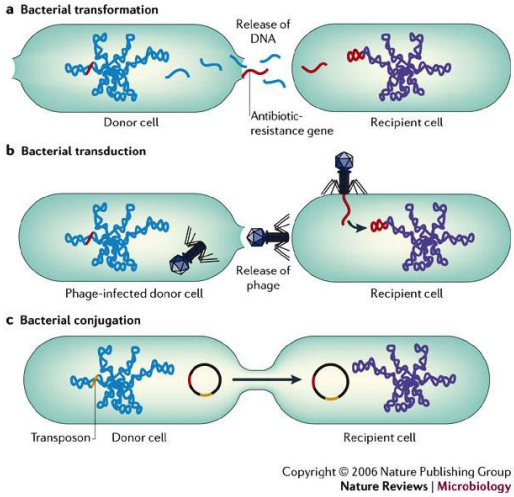
Emerging pathogens

Diversity, moving towards "*fitness*" *and Emerging Pathogens*

Photo Courtesy:
http://www.daviddarling.info/encyclopedia/B/binary_fission.html





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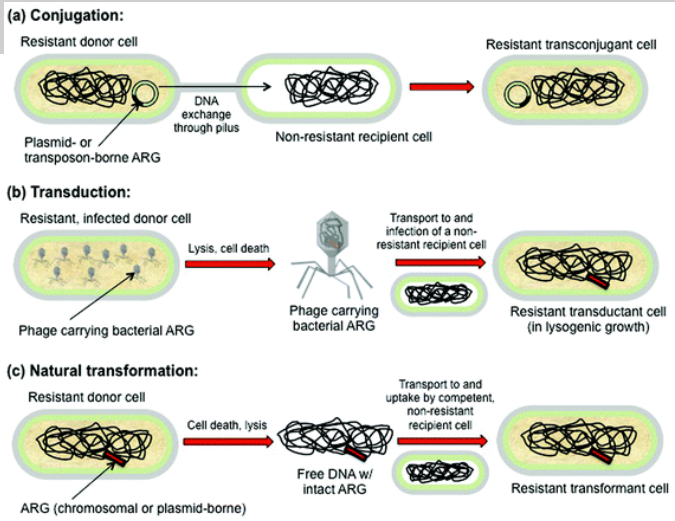
Horizontal Gene Transfer



Donn, 2012

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Planktonic cells and Biofilm Communities

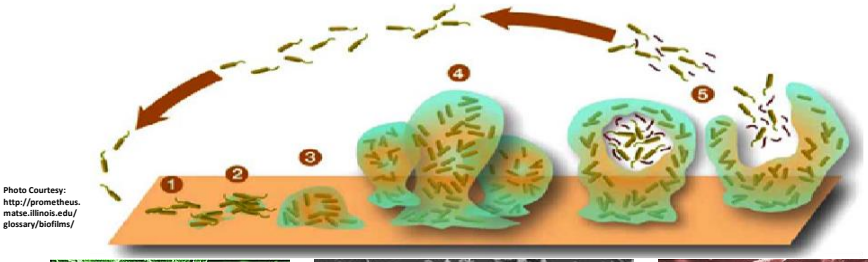

Photo Courtesy: http://prometheus.matse.illinois.edu/glossary/biofilms/

Photo Courtesy: http://micro-writers.egybio.net/blog/?tag=antibiotic-resistance

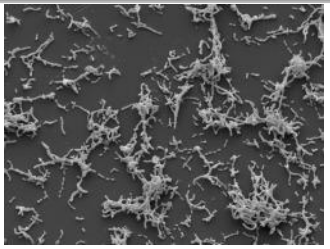

Photo Courtesy: http://www.ifenergy.com/50226711/boosting_microbial_fuel_cells_with_biofilm.php

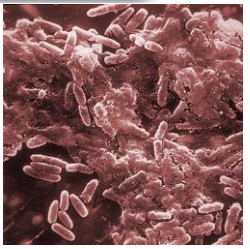

Photo Courtesy: http://www.microbiologybytes.com/blog/category/biofilms/

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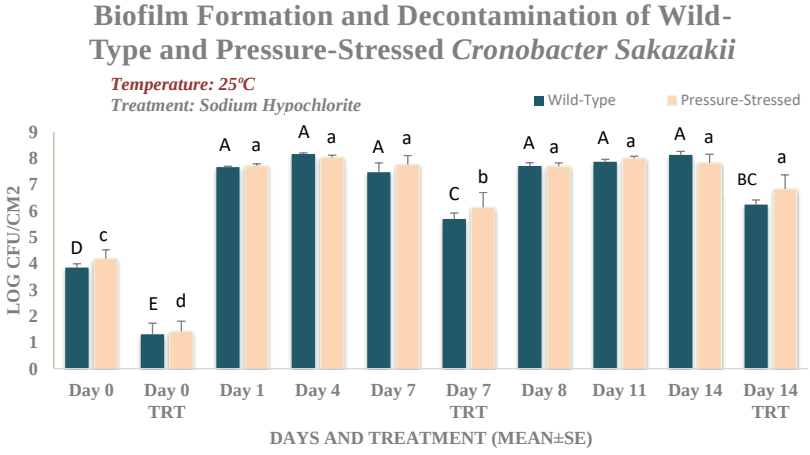
Cronobacter Sakazakii



Allison et al., 2017

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Quorum Sensing and Biofilm formation

Shiga toxin-Producing E. coli and antibiotics treatment

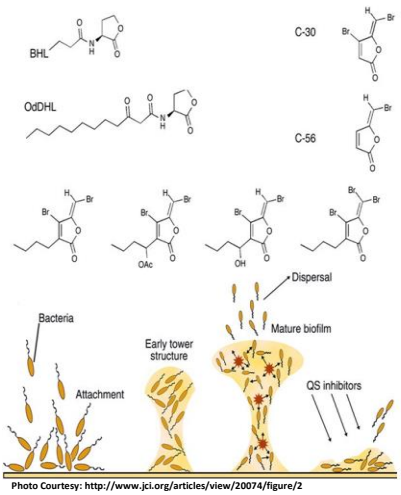

Photo Courtesy: http://www.jci.org/articles/view/20074/figure/2

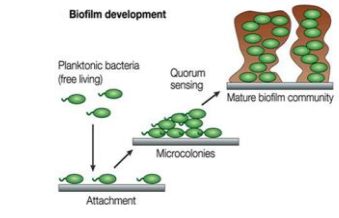

Photo Courtesy: http://labrat.fieldofscience.com/2010/07/quorum-sensing-and-biofilms.html

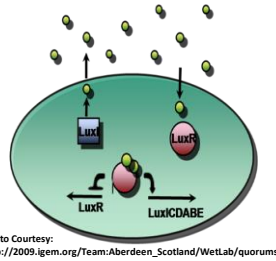

Photo Courtesy: http://2009.igem.org/Team:Aberdeen_Scotland/WetLab/quorumsensing

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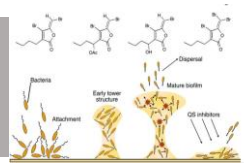
Infectious Diseases in Animals and Human is a Moving Target…



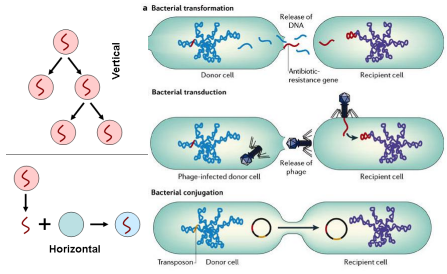
- It is estimated only 1% of microbial community has been identified.
- Currently **etiological agent** of 80.3% of foodborne illnesses, **56.2% of hospitalization**, and 55.5% of deaths remain unknown.

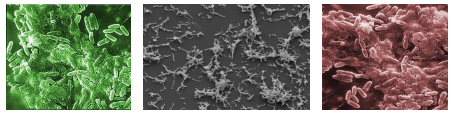
"Emerging" Pathogens:

- Vertical and horizontal gene transfer spores and biofilm formation
- Quorum sensing and cell to cell communication

"*It is the microbes who will have the last word.*"
-Louis Pasteur

Photo Courtesy: http://www.jci.org/articles/view/20074/figure/2





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http://www.ifenergy.com/50226711/boosting_microbial_fuel_cells_with_biofilm.php
http://micro-writers.egybio.net/blog/?tag=antibiotic-resistance

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A superbug resistant to every available antibiotic in the U.S. kills Nevada woman

79424

EMAIL

BY HELEN BRANSWELL, STAT *January 13, 2017 at 10:01 AM EST*

Rare strain of E. coli strikes across Canada: source unknown

BY NEWS DESK | JANUARY 14, 2017

A dozen cases of E. coli O121 have been confirmed in three Canadian provinces, according to matching genetic fingerprint data, but the source of the outbreak has not yet been identified.

The Public Health Agency of Canada reports four of the rare O121 cases were confirmed in British Columbia, four in Saskatchewan and four in Newfoundland and Labrador. The illness onset dates were in November and December of 2016.

Four of the victims have been hospitalized. Those individuals have recovered or are in the process of recovery. An investigation to

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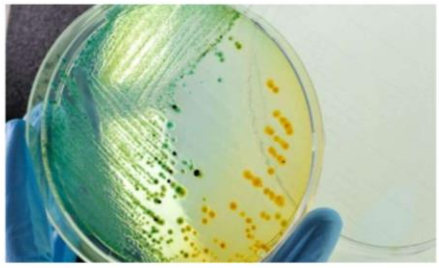
AUGUST 23, 2019

Multidrug-resistant salmonella outbreak characterized



(HealthDay)—A recent multidrug-resistant (MDR) *Salmonella enterica* serotype Newport outbreak, affecting patients in 32 states, was associated with soft cheese and beef consumption, according to a report published in the Aug. 23 issue of the U.S. Centers for Disease Control and Prevention *Morbidity and Mortality Weekly Report*.

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Epidemiology of Foodborne Diseases

- **Based on data from 1990s:** *(Mead et al., 1999)*

76 million illnesses, 323,000 hospitalizations, **5,200 deaths** in the United States.

- **More recent estimates show:** *(Scallan et al., 2011)*

47.8 million illnesses, 127,839 hospitalizations, and more than **3,037** deaths in the United States.

- 9.4 million illnesses, 55,961 hospitalizations, and 1,351 deaths are cause by 31 known foodborne agents.
- In addition to consumer insecurity, foodborne diseases cause around $**77.7 billion** for losses in productivity and economical losses.
- Approximately 30% of population are especially "at risk" for foodborne diseases (The **YOPI**'s: The young, the old, Pregnant, and Immunocompromised)

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Significant foodborne pathogens…
based on Mead et al., 1999 and Scallan et al., 2011 studies

- **Leading etiological agents for illnesses**: *Norovirus* (58%), Nontyphoidal *Salmonella* serovars (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp (9%).
- **Leading etiological agents for hospitalization:** Nontyphoidal *Salmonella* serovars (35%), *Norovirus (26%), Campylobacter* spp (15%), and *Toxoplasma gondii* (8%).
- **Leading etiological agents for death:** Nontyphoidal *Salmonella* serovars (28%), *T. gondii* (24*%), Listeria monocytogenes* (19%), and *Norovirus (11%).*

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Signs and Symptoms of Foodborne Diseases

- Mild illness (no medical care sought)
- **Guillain–Barré syndrome** (*Campylobacter* and *Salmonella*)
- **Post-infectious irritable bowel syndrome** (*Campylobacter* and *Salmonella*)
- **Reactive arthritis** (*Campylobacter* and *Salmonella*)
- **Haemolytic uraemic syndrome** (*E. coli* O157)
- **End-stage renal disease** (*E. coli* O157)
- Death

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Significant foodborne pathogens…
based on Scallan et al., 2015 study

- **Disability adjusted life year** (DALY). *DALY: Loss of life and health due to illness*
- Non-typhoidal *Salmonella* (329000)
- Toxoplasma (32700)
- *Campylobacter* (22500)
- Norovirus (9900)
- *Listeria monocytogenes* (8800)
- *Clostridium perfringens* (4000)
- *Escherichia coli* O157 (1200)

One DALY can be thought of as one **lost year of "healthy" life**.

DALY= YLL+YLD

YLL: Years of Life Lost (YLL) due to **premature mortality** in the population
YLD: Years Lost due to Disability (YLD) for **people living with the health condition**

Source: WHO, 2019

62% bacterial agents; 29% parasitic agents; 9% viral agents

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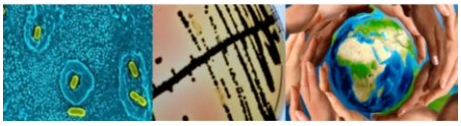
Foodborne Pathogens of Public Health Concerns *>200 foodborne diseases*



- *Salmonella* serovars
- *Staphylococcus aureus*
- *Campylobacter* spp.
- Shiga Toxin-Producing *Escherichia coli* (STEC)
- *Vibrio* spp.
- *Yersinia enterocolitica*
- *Listeria monocytogenes*
- *Cronobacter sakazakii*

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Salmonella serovars

- **Annual illness (death): 1,027,561 (378) in American adults and children**
- **Infection** causes nausea, vomiting, diarrhea, fever, headache
- **Primary sources**: Intestinal tract of people and animals
- **Transmitted by** meat, poultry, eggs, raw milk, unpasteurized juice, many other foods (nuts, spices, produce, chocolate, flour) [Low moisture environment]
- **Contributing factors**: cross-contamination, undercooked food, poor agricultural practices

Growth parameters	Minimum	Optimum	Maximum
Temperature	41°F (5.2°C)	95-109°F (35-43°C)	115°F (46.2°C)
pH	3.7	7-7.5	9.5
a_w	0.94	0.99	>0.99
Other	Non-sporeformer		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2nd edition, Scallan et al., 2011, and FSPCA

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Staphylococcus aureus

- **Annual illness (death): 241,148 (6) Americans every year**
- Both causes infection and toxico-infection
- Produces **heat stable toxins** after extensive growth
- **Primary sources**: Boils, nasal passages and skin (around 20% positive on nasal passage, >10% hands)
- **Transmitted** by recontaminated **cooked foods**, and foods with high salt or high sugar (**Gram-positive, poor competitor**)
- **Contributing factors**: Recontamination and **time/temperature abuse**

Growth parameters	Minimum		Optimum		Maximum	
	Growth	Toxin	Growth	Toxin	Growth	Toxin
Temperature	45°F (7°C)	50°F (10°C)	99°F (37°C)	104-113°F (40-45°C)	122°F (50°C)	118°F (48°C)
pH	4	4	6-7	7-8	10	9.8
a_w	0.83	0.85	0.98		>0.99	
Other	Poor competitor, non-sporeformer					
Atmosphere	Facultative – grows with or without oxygen, but slower without					

Sources: ICMSF 1995 and Bad Bug Book 2nd edition, Scallan et al. 2011, and FSPCA

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Campylobacter spp.

- **Annual illness (death): 845,024(76)**
- Infection causes diarrhea, and potential nerve damage
- **Primary sources**: Intestinal tract of animals
- **Transmitted** by raw poultry, raw milk products, contaminated water, poultry (dump tank, nearly 80%). Relatively high infective dose
- **Contributing factor**: cross contamination and undercooking

Growth parameters	Minimum	Optimum	Maximum
Temperature	86°F (30°C)	108-109°F (42-43°C)	113°F (45°C)
pH	4.9	6.5-7.5	9.5
a_w	>0.987	0.997	-
Other	Non-sporeformer		
Atmosphere	3-5% oxygen optimum		

Sources: ICMSF 1995 and Bad Bug Book 2nd edition and FSPCA

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Shiga Toxin-Producing *Escherichia coli* (STEC)

- **Annual illness (death): 176,152 (20)**
- **Infection causes** bloody diarrhea, and sometimes kidney failure and death [HUS in kids]
- **Primary sources**: Intestinal tract of ruminant animals (e.g., cows, sheep)
- **Transmitted** by raw and undercooked beef, poultry, leafy greens, and unpasteurized milk and juices
- **Contributing factors**: poor GAP, inadequate heating, and person-to-person

Growth parameters	Minimum	Optimum	Maximum
Temperature	**44°F (6.5°C)**	95-104°F (35-40°C)	121°F (49.4°C)
pH	4	6-7	10
a_w	0.95	0.995	-
Other	Non-sporeforming		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2nd edition,Scallan et al. 2011, and FSPCA

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Vibrio spp.

- Causing about **80,000 illness and 100 death** annually in the United States.
- **Infection symptoms** vary depending on strain, ranging from diarrhea to high fever
- Vibrio is a **halophilic bacterium** and is a major concern in aquaculture industry
- **Primary sources**: Salt water environments and seafood
- Requires salt to reproduce (halophile)

Growth parameters	Minimum	Optimum	Maximum
Temperature	41°F (5°C)	99°F (37°C)	114°F (45.3°C)
pH	4.8	7.8-8.6	11
a_w	0.94	0.98	0.996 (10% NaCl)
Other	Non-sporeformer, requires salt		
Atmosphere	Facultative - grows with or without oxygen		

Sources: Seafood Hazards Guide 2011, ICMSF 1995 and Bad Bug Book 2nd edition

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Yersinia enterocolitica

- *Not a reportable disease, no statistics available*
- **Infection causes** abdominal pain, fever and diarrhea. May mimic appendicitis.
- **Primary sources**: Raw pork, raw milk
- **Contributing factors**: Cross-contamination between raw pork products and RTE foods

Growth parameters	Minimum	Optimum	Maximum
Temperature	30°F (-1.3°C)	77-99°F (25-37°C)	108°F (42°C)
pH	4.2	7.2	10
a_w	0.945	-	-
Other	Non-sporeformer, raw milk in fridge?		
Atmosphere	Facultative - grows with or without oxygen		

Sources: Seafood Hazards Guide, ICMSF 1995, and Bad Bug Book

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Listeria monocytogenes

- **Infection causes** severe illness in susceptible people – mortality 15-30%
- **Primary sources**: Occurs widely in agriculture (soil, plants and water) –(Important during pregnancy)
- **Transmitted by**: Refrigerated RTE foods that support growth (South Africa, Largest in History in 2018)
- **Contributing factors**: Environmental pathogen spread by environmental contamination, equipment, people, incoming raw ingredients (ubiquitous in nature)
- **Common in domesticated ruminates particularly** sheep, poultry, and birds.
- **Could cause sporadic and farm outbreaks in ruminants**
- **Could cause: Encephalitis, late abortion, and GI problems in ruminants**.

Growth parameters	Minimum	Optimum	Maximum
Temperature	31°F (-0.4°C)	99°F (37°C)	113°F (45°C)
pH	4.4	7.0	9.4
a_w	0.92	-	-
Other	Non-sporeformer		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2nd edition

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Cronobacter Sakazakii

- **Recently reclassified** bacteria, formerly known as ***Enterobacter sakazakii***
- The **Genus *Cronobacter*** was derived from the Greek term "Cronos," a Titans of ancient mythology who swallowed each of his infants as soon as they were born (he was afraid to be replaced by his infants).
- The **species name, *sakazakii***, is named in honor of the Japanese microbiologist, Riichi Sakazaki, when the bacterium was first explained in 1980.
- Gram-negative, rod-shaped bacteria.
- Facultative anaerobic
- The growing temperature range is 6°C-45°C
- Primarily associated with **Powered Infant Formula**
- There has been several outbreaks associated with the bacterium and neonatal meningitis and death including two outbreaks in **Tennessee** (**1998 and 2001**).

APHA Compendium of Methods, Salfinger and Lou Tortorello, Fifth Edition

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Cronobacter Sakazakii

Prevention (CDC & WHO guidelines)

- Breastfeed
- Practice careful hygiene
- Clean and sanitize properly
- Prepare Powered Infant Formula as recommended

Symptoms:

- poor feeding response,
- irritability,
- jaundice,
- grunting **respirations**,
- **instability of body temperature**,
- Could lead to: **seizures, brain abscess**, hydrocephalus, and developmental delay, or **death**

APHA Compendium of Methods, Salfinger and Lou Tortorello, Fifth Edition

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Disease Occurrence
Level of disease

- **Sporadic** refers to a disease that occurs infrequently and irregularly.
- **Endemic** refers to the constant presence and/or usual prevalence of a disease or infectious agent in an animal or human population within a geographic area.
- **Hyperendemic** refers to persistent, high levels of disease occurrence.
- **Epidemic** refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.
- **Outbreak** carries the same definition of epidemic, but is often used for a more limited geographic area.
- **Pandemic** refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

Source: CDC

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Exercise 1

For each of the following situations, identify whether it reflects:

A. Sporadic disease

B. Endemic disease

C. Hyperendemic disease

D. Pandemic disease

E. Epidemic disease

1. ____ 22 cases of Salmonellosis occurred within 3 weeks among residents of a particular neighborhood (usually 0 or 1 per year)
2. ____ Average annual incidence was 364 cases of pulmonary tuberculosis per 100,000 population in one area, compared with national average of 134 cases per 100,000 population
3. ____ Over 20 million people worldwide died from influenza in 1918–1919
4. ____ Single case of Aspergillosis was diagnosed in a community
5. ____ About 60 cases of listeriosis are usually reported in this region per week, slightly less than the national average

Source: CDC, with modification

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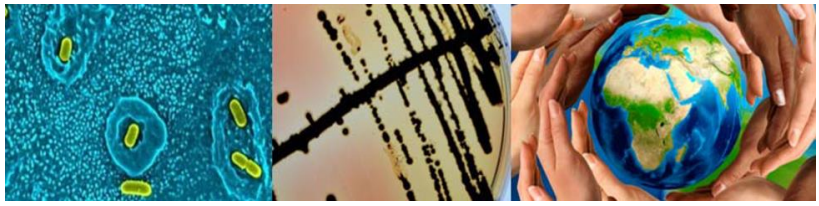

PART II: Epidemiology of Transboundary Zoonotic Infectious Diseases

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Equine Encephalitis Viruses

- Three viruses:
  - Eastern (EEE)
  - Western (WEE)
  - Venezuelan (VEE)
- Transmitted by mosquitoes (**vector-borne disease**)
- **Birds** could be **asymptomatic carrier**
- **Clinical signs** in human and Equids (Horses, mules, donkeys)
  - No to mild signs to
  - Flu-like illness
  - Encephalitis in small proportions

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Equine Encephalitis Viruses

- The viruses are **very unstable** in environment
- **Supportive care** is the only current treatment
- **Vaccine are available** for Equine
- **Vaccine for human very expensive** primarily for:
  - Researchers
  - Public health workers with enhanced exposure

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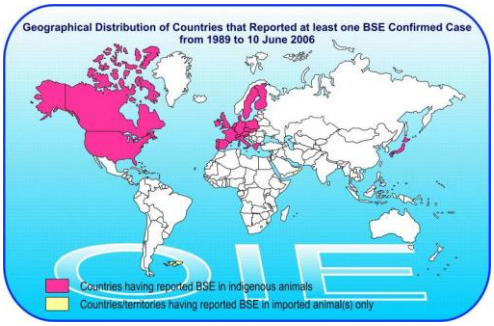
BSE- Bovine Spongiform Encephalopathy

- Caused by **prions** (infectious protein particles)
- **Cattle and humans** are susceptible
- A neurological disease that could be fatal
- **Transmitted** by:
  - Consumption of **scrapie-infected feed**
  - **Spontaneous mutation**
- Distribution is worldwide



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Symptoms of BSE

- In Cattle
  - Incubation period is 2-8 **years**
  - Initial signs are mild and subtle
  - At final stages
    - tremors
    - loss of balance
    - death
- In Humans
  - Unknown incubation period (many years to many decades)
  - Neurological signs
  - Depression and schizophrenia-like symptoms
  - Could lead to death

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BSE Management

- **Very resistant infectious agent**
- **Currently no effective treatment or vaccine**
- Prevention:
  - **surveillance program** and **testing**
  - **Restriction in trade**
  - **Animal feed regulation** (bone meals and mammalian products)
- Outbreak in 2001-2002 in United Kingdom: cost the industry 3.7 billion Euro

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Hendra Virus

- Viral disease **consider as emerging** (**first observed in Australia**)
- Natural infections had been **reported only** in:
  - Horses
  - Humans
- Current transmission by:
  - Fruit bats
  - **Bodily fluids** and **urine** of those infected
- Clinical signs in Horses
  - Sudden respiratory signs
  - Nasal discharge
  - Fever
  - Encephalitis
  - Sudden death
- Clinical signs in Humans
  - Flu-like illness
  - respiratory complications
  - **Highly fatal in human, could be as high as 2 in 3 cases**

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Hendra Virus

- Little is known about pathogen
- Highest level of security (**biosafety level 4**) needed for studying the pathogen
- Could cause high mortality in humans
- Currently no treatment option is available

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Q Fever

- Bacterial diseases caused by ***Coxiella burnetii***
- Transmission by:
  - Aerosol
  - Direct contact
  - Ingestion
  - Ticks
  - Raw milk
  - Clinical signs in sheep, cattle and goats
  - Can be **asymptomatic**
  - **abortions possible**
- Clinical sign in humans
  - **Flu-like pneumonia**

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Q Fever

- Highly infectious bacteria
- Aerosols could **travel ½ mile by wind**
- Often **self-limiting disease** in human and animals
- **Antibiotic** required in case of complications (human and animals)
- **Vaccines for human** in some countries
- Prevention in human:
  - **Consumption of pasteurized milk**
  - **Limited exposure to diseased animals**

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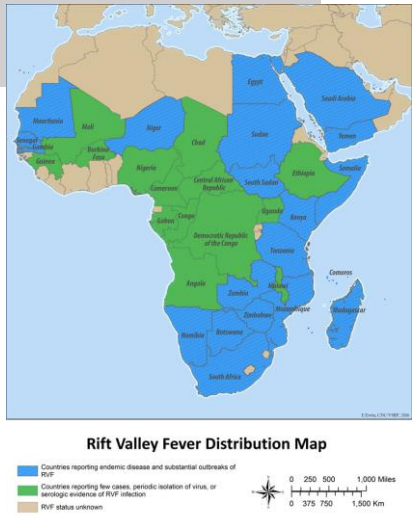
Rift Valley Fever

- It is a **viral disease** caused by genus *Phlebovirus* in the family *Bunyaviridae*
- Commonly observed in **domesticated animals**:
  - Cattle
  - Buffalo
  - Sheep
  - Goats
- Has ability to infect and cause illness in humans (i.e. is a **zoonotic disease**)
- First reported in **Kenya**'s Rift Valley in the early **1910**
- Currently and **endemic throughout most Africa**



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Rift Valley Fever

- The most notable RVF epizootic occurred in **Kenya in 1950-1951**, resulting in the death of an estimated 100,000 sheep.

Transmission:

-Mosquitoes (**vector-borne disease**)

*Virus transmission from **female mosquitos** to their **offspring by the eggs***

***Excessive rainfall** enables more mosquito eggs to hatch*

-Aerosolized virus from infected animals

-Direct contact with bodily fluids of infected animals

Symptoms:

-**Animal**s: Abortion and death in neonates

-**Humans**: Flu-like symptoms, fever, headache, eye and systematic infection

Outbreaks of disease in animal populations are called "**epizootics**."

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Rift Valley Fever

Current Epidemiology/WHO estimates:

- As high as **5 kg (10 lb) of virus** could be aerosolize every year
- Leading to **350,000 cases of human illness**
- About **400 death episodes (1% mortality**)
- The virus is **very stable in environment**
- Could be in activated by various chemical sanitizers

Recent Outbreaks:

- **Niger, 2016:** 33 deaths
- **Uganda, 2016:** 3-5 confirmed cases
- **South Africa and Namibia: 2009-2011:** 25 human death, >14,000 confirmed animal cases

Source: CDC, https://www.cdc.gov/vhf/rvf/prevention/index.html

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Rift Valley Fever

Prevention in Livestock:

- Vaccination of ruminants in endemic area
- Control of mosquitoes
- Limit human exposure with infected animals
- Separation of infected animals

Prevention in Human:

- No vaccines are currently available for human vaccination
- Surveillance (close monitoring for infection in animals and humans)
- There is no documented case of **human to human transmission** of RVF virus

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Trichinellosis (also known as Trichinosis)

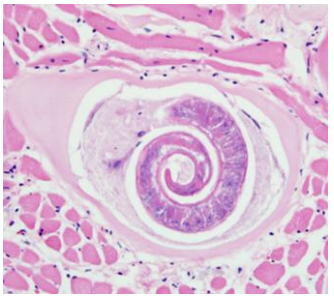
- Cause by a parasitic agent
- Infection very common in:

  -Wild carnivorous (**meat-eating) animals** such as bear or cougar

  -Omnivorous (**meat and plant-eating) animals** such as **domestic pigs or wild boar**

- Infection in human:

-**Eating raw or undercooked meat** of animals infected with the larvae of a species of worm called *Trichinella*



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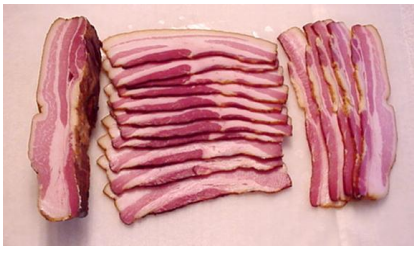
Trichinellosis (also known as Trichinosis)

- **Abdominal symptoms** can occur **1-2 days after infection**
- **Further symptoms** usually start **2-8 weeks** after eating contaminated meat
- **Symptoms** may range from very mild to severe
- **Mild cases** of trichinellosis are typically misdiagnosed **as flu**
- **Primary signs:** Nausea, diarrhea, vomiting, fatigue, fever, and abdominal.
- **Further signs:** headaches, fevers, chills, cough, swelling of the face and eyes, aching joints and muscle pains, itchy skin, diarrhea, or constipation may follow the first symptoms
- **Diagnosis:**
- A blood test or
- Muscle biopsy



Source: CDC, 2018

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Trichinellosis (also known as Trichinosis)

- **Prevention:**
- For **Ground Meat** (including wild game, excluding poultry)
  Cook to at least **160° F (71° C)**
- For All **Wild Game** (whole cuts and ground)
  Cook to at least **160° F (71° C).**

Other preventive measure

- **Wash your hands** with warm water and soap after handling raw meat and hunting
- **Clean meat grinders** thoroughly after each use.
- Curing (salting), drying, smoking, or microwaving meat alone **does not** consistently kill infective worms;
- **Homemade jerky and sausage** were the cause of many cases of trichinellosis reported to CDC in recent years.
- **Freezing: [FL and TN and freezing cycles]**
- **Might** inactivate the parasite for **pork less than 6 inches** thick for 20 days at 5°F (**-15°C**)
- **Might not** be effective to inactivate all parasite in **wild game** meats due to **freeze-resistant phenotypes** of parasite

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Foot-and-Mouth Disease

- Highly communicable **viral disease** (*Aphthovirus* of the family Picornaviridae).
- **Livestock hosts**:
  cattle, pigs, sheep, goats (experimental infections in alpacas and llamas).

Symptoms:

- fever
- vesicles in the **mouth** and on the muzzle, teats, and feet.
- In susceptible population, **morbidity reaches 100%**

Transmission:

Spreads through direct contact or aerosolized virus via:

- respiratory secretions
- milk
- semen
- **ingestion of feed** from infected animals (**meat, offal, milk**).

Source: Merck Veterinary Manual

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Foot-and-Mouth In the United States

- US had total of **9 FMD outbreaks (many sporadic cases)** in addition to many sporadic cases
- **Historic outbreak and some of the earliest regulation:**
- 1870, 1880 and 1884: **imported** animals, lead to **federal inspection and quarantine programs** that had been successful to preventing the disease to occur from imported animals since 1884. [The book Jungle]
- 1902, 1908, 1914, 1924 (twice) and 1929 from pathogen existing on **mainland**
- **The six late**r were controlled by: **stopping movement** and **stamping out**
- Currently **only sporadic cases** in north America that is **controlled aggressively** with stamping out
- [Without continued public health program may easily return, like measles]

Source: Center for Food Security and Public Health, Iowa, Zoonotic Diseases
Source: Merck Veterinary Manual

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Foot-and-Mouth- Global Prevalence

World Organization for Animal Health (OIE):

- 178 member countries
- 96 countries are **endemic** (never been free of FMD)
- 66 countries **free of FMD**
- 11 countries have **free zones** (with or without vaccination)
- 5 countries were free, recently suffered from **re-emergence of FMD**

Source: Center for Food Security and Public Health, Iowa, Zoonotic Diseases
Source: Merck Veterinary Manual

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Evolving Practices in Handling FMD Outbreak

- Stop movement
- Stamping Out
- Slaughter of all clinically affected and in-contact susceptible animals (within 24 hours or as soon as possible) [Feedlot Operations]
- **Trace back/Trace forward epidemiology**: **28 days prior to outbreak**
- Rapid Diagnostics
- Vaccination (Vaccinate to kill/slaughter; Vaccinate to live)

Source: Center for Food Security and Public Health, Iowa, Zoonotic Diseases
Source: Merck Veterinary Manual

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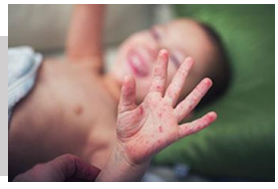
Burden of the Disease



- Animals at risk in the United States
  - 100 million cattle
  - 60 million swine
  - 7 million sheep
  - 40 million wildlife
  - Not horses
- **Humans rarely infected**
- Huge economic impact

- **Hand, foot, and mouth disease** is a common viral illness that usually **affects infants and children younger than 5 years** old. However, it can sometimes occur in older children and adults
- There is **no specific treatment** for hand, foot, and mouth disease. However, you can do some things to relieve symptoms: OTC **pain relieve** and mouthwash to reduce symptoms. (Immunocompromised)

Animal Disease Emergencies, 2008 - IHSEMD, IDALS, CFSPH; https://www.cdc.gov/hand-foot-mouth/index.html; Photo courtesy: CDC

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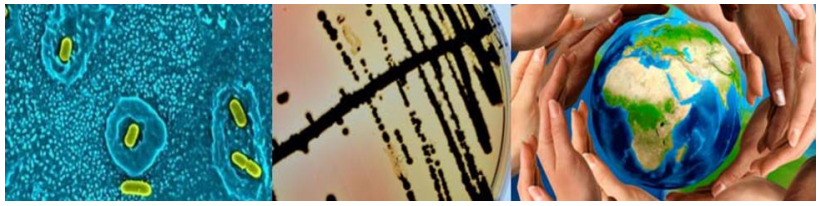

PART III: Infectious Diseases in Landscape of Climate Change

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Climate Change and Global Environmental Changes

- **(1) Warming Temperature of Earth Surfaces and the Oceans:**
- The earth has warmed 0.13°C/decade since 1957
- This rate is twice is fast as the previous century
- **(2) Changes in the Global Water Cycle (Hydrologic Cycles):**
- The past century has experienced major change in **annual precipitation**.
- Many areas: **severe, long-term drought; some increased precipitation; increase in intensity storms**.
- **(3) Declining Glacier and Snowpack:**
- Decreasing in volume and mass of glaciers.
- Affecting 1 billion people living in river watersheds fed by glaciers

Source: 2016 Public Health Institute/Center for Climate Change and Health

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Climate Change and Global Environmental Changes

- **(4) See Level Rise:**
- Warmer water has higher expansion in volume
- Melting glaciers and snowpacks also contribute to ocean rise
- Leads to: **Loss of land**, occurring in many parts of the world (Maldives as an example)
- Current rate is around 1.7 cm/year, accelerated in recent years/
- **(5) Ocean Acidification:**
- Oceans absorb 25% of emitted CO2
- This leads to acidification of sea water acidification (carbonic acid production)

Source: 2016 Public Health Institute/Center for Climate Change and Health

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Climate Change and Infectious Diseases

- **Three Effects of Climate Change on Infectious Diseases**
- **Climate change (direct effects):** Changes in survival and transmission patterns of bacteria, viral, and parasitic agents.
- **Climate-dependent (indirect effects):** Temperature and moisture affects fungal growth and formation of mycotoxins.
- **Extreme weather events and natural disasters:** Climate change increases frequency and severity extreme weather events.

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Climate Change: Bacteria, Viruses, and Parasitic Protozoa

- **Bacteria, Viruses, and Parasitic Protozoa**
- Collectively estimated to cause **2 billion illness globally**
- Causing **31 million (DALY**) Disability-Adjusted Life Year
- **29% of these disease are estimated to be foodborne**.

- Temperature and humidity could greatly affect the growth of organisms:
- ***Salmonella* as an example**: 50,000 global death in 2010.
- **1°C increase** (above 5°C) in weekly temperature lead to **5 to 10% increases in** cases (WHO, 2018) **[1,000,000* 0.05= 50,0000 in the U.S.]**
- ***Vibrio Cholerae*:** currently 760,000 global illness/24,000 death per year.

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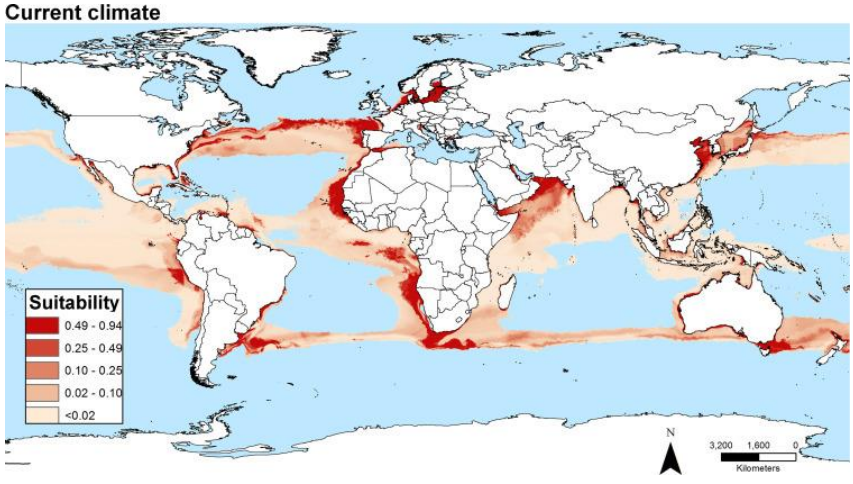
Vibrio cholerae proliferation in sea water: Current Climate



Escobar LE et al. Acta Tropica 2015;149:202-11

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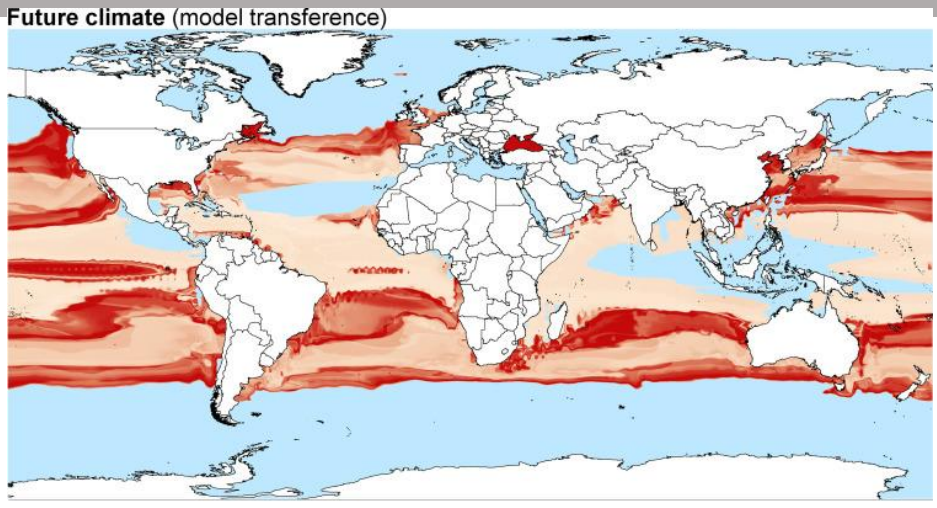
Vibrio cholerae proliferation in sea water: Business-as-Usual Projection in 2100



Escobar LE et al. Acta Tropica 2015;149:202-11

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Climate Change: Mycotoxin and Phycotoxins

- **Mycotoxins:**
- Compounds produced by **variety of fungi**
- At very **high concentrations acute health problem** and death
- **Long-term exposure**: various **forms of cancer**
- Estimated **25% of world's yearly crop** contaminated with mycotoxins
- Occur more frequently in **hot and humid regions**
- Human exposure:
- **Dietary exposure**: **direct** (contaminated crop) or **indirect** (animal derived food consumed contaminated feed)
- Change in climate could increase moisture in some areas **12-14%** (FAO, 2016)
- **At 2°C increase**, aflatoxin growth will become an emerging concern in **North America** and Europe.

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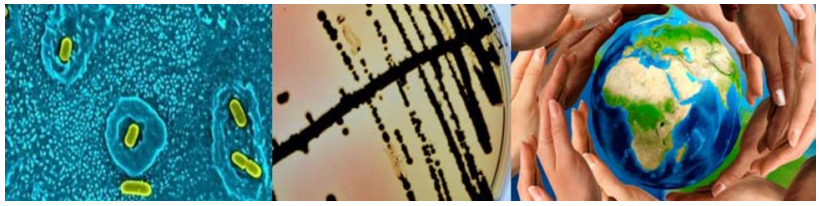

Additional Resources

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Additional Resources and References:

Centers for Disease Control and Prevention:

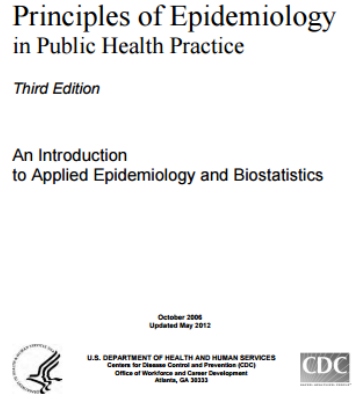
https://www.cdc.gov/ophss/csels/dsepd/ss1978/ss1978.pdf

Center for Food Security and Public Health, Iowa, Zoonotic Diseases:

http://www.cfsph.iastate.edu/Zoonoses/

Food and Agriculture Organization of the United Nation:

http://www.fao.org/emergencies/emergency-types/transboundary-animal-diseases/en/



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Additional Resources

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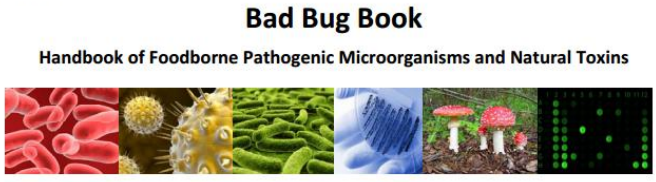

Bad Bug Book

Handbook of Foodborne Pathogenic Microorganisms and Natural Toxins

Introduction

Food safety is a complex issue that has an impact on all segments of society, from the general public to government, industry, and academia. The second edition of the Bad Bug Book, published by the Center for Food Safety and Applied Nutrition, of the Food and Drug Administration (FDA), U.S. Department of Health and Human Services, provides current information about the major known agents that cause foodborne illness. The information provided in this handbook is abbreviated and general in nature, and is intended for practical use. It is not intended to be a comprehensive scientific or clinical reference.

Under the laws administered by FDA, a food is adulterated if it contains (1) a poisonous or otherwise harmful substance that is not an inherent natural constituent of the food itself, in an amount that poses *a reasonable possibility* of injury to health, or (2) a substance that is an inherent natural constituent of the food itself; is not the result of environmental, agricultural, industrial, or other contamination; and is present in an amount that *ordinarily* renders the food

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Thank you

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