Climate Change, Food Safety, and Public Health Microbiology Training, Outreach, and Technical Assistance in Republic of Georgia

Trip Report (June 2024): USAID Project on May 25 to June 13

Dr. Aliyar Cyrus Fouladkhah, PhD, MPH, CFS, CPH
Founding Director, Public Health Microbiology Foundation[SM]
Yale School of Public Health Alumnus

It was a great pleasure for me to return to the culturally-rich country of Georgia for a USAID Assignment. The current assignment had the overall objective of providing support for building capacity for safe and efficacious processing of food products and raising awareness about public health microbiology under the landscape of climate change. The project has three sub-objectives of (i) Holding a multi-day certification workshop in Tbilisi (ii) Supporting an entrepreneur in Tbilisi for risk assessment for RTE beverages and sushi, and (iii) Microbiology testing capacity building by providing training and supplies for a women-owned business in an underserved region of Zugdidi.

During the **first sub-objective**, a multi-day workshop was held for 11 participants with roles in NGO, government, and the food industry. In addition to the main curriculum, the workshop discussed important implications of climate changes on local and global commerce, transboundary infectious diseases of importance in the region, microbial food safety hazards, chemical (including radiological) hazards in food, and important food policies and regulations of local and international commerce. Financial contribution of the Public Health Microbiology Foundation^{SM} for this sub-objective is $7,150 for training certificates with a market value cost of $650 per person (11 certificates provided, 11*650= $7,150)

During the **second sub-objective**, a local food business with 66% ownership by first-time women entrepreneurs was visited, and process authority feedback about further ensuring the safety of the RTE beverage and non-beverage food products was provided. Specifically, important information about the prevention of Botulism, developing SSOPs, and risk assessment and hazard analysis was provided to support the processor in developing HACCP plans for their operation.

During the **third sub-objective**, supplies, materials, and training were provided to the laboratory in Zugdidi to ensure the successful execution of microbial testing. Special emphasis was placed on ensuring compliance with biohazard regulations to ensure the safety of the lab members and residents in the region. The meeting was supplemented with visiting a local hazelnut factory with exports to Europe, and North America, and Asia and by testing the samples from the factory for aerobic plate counts. After the donation of supplies and training, the local laboratory is now fully capable of conducting basic microbiology testing for food and water samples as well as environmental swabs for validation of cleaning and sanitation procedures. Financial contribution

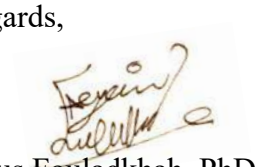
of the Public Health Microbiology Foundation[SM] for this sub-objective is $5,250 for microbiological media and consumables, microbiology equipment (electric sterilizer, series 2100 by Prestige Medical) and electronic supplies.

Adoptable Recommendations:

- Incorporation of biological and chemical hazards discussed in day-to-day operation of food industry and government agencies participants (sub-objective 1)
- Implementation of Process Preventive Control, Allergens Preventive Control, Sanitation Preventive Control, and Supply Change Preventive Control as part of the Food Safety Plan Development by the Participants (sub-objective 1).
- Incorporation of provided best practices for defrosting of RTE fish products to avoid time-temperature abuse and eliminating the risk of botulism (sub-objective 2).
- Implementation of microbial testing procedures articulated during the training in Zugdidi for Aerobic Plate Count testing of food, water, soil, and environmental samples (sub-objective 3).

Special thanks are needed for great colleagues both in Washington and Tbilisi USIAD offices, to the hosts in Tbilisi and Zugdidi and the translator for the workshop for all they have done to support this productive and impactful program.

Sincere regards,



Aliyar Cyrus Fouladkhah, PhD, MS, MPH, MACE, CFS, CPH

Associate Professor, Tennessee State University

Faculty Director, Public Health Microbiology Laboratory

Founding Director, Public Health Microbiology Foundation[SM]

Yale School of Public Health Alumnus

Workshop Invitation

https://publichealthmicrobiology.education/

Public Health Microbiology Laboratory
Tennessee State University
Aliyar Cyrus Fouladkhah, Faculty Director
CARP Research Complex Laboratories 112 & 114,
3500 John A. Merritt Boulevard, Nashville, TN 37209
Office: (615)963-7471; Lab: (615)963-1578; Mobile: (970)690-7392
Email: afouladk@tnstate.edu or aliyar.fouladkhah@aya.yale.edu

Public Health & Food Safety Workshop, Tbilisi, Georgia
May 28 to 30 2024

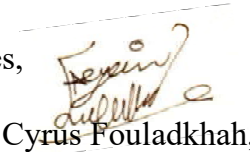
Dear participants,

It is my pleasure to welcome you to our 2024 food safety and public health certification workshop. This event is sponsored by the Public Health Microbiology Foundation in Nashville, TN and Washington and Tbilisi USAID ACDI/VOCA program. During this event, in addition to information from the public health microbiology program in Nashville, I will cover important climate change, food safety, and infectious disease topics. This workshop will be held in person. Due to ongoing national and global respiratory pandemic/endemic of new FLiRT variant, participants arw requested to adhere to public health guidelines including wearing high-quality masks and practicing social distancing to minimize the risk of respiratory disease transmission.

In-person participants are expected on May 28 to 30 2024, during the below-mentioned times. We will additionally hold optional meetings on week of June 3, 2024 for further specific and one-by-one discussions/consultation about food safety and public health practices. Below please find the tentative agenda for the meeting. You could also access the survey weblink and QR code that you could use for providing feedback to the instructor at the end of the workshop. I hope you find this important and timely workshop of assistance for further enhancing your career, and improving the safety of your operation for meeting and exceeding the regulatory requirements for national and global commerce while ensuring the public's health.

If you have any question about the workshop, please take the liberty in contacting me at +1(970) 690-7392 or via email (aliyar.fouladkhah@aya.yale.edu).

Best wishes,



Dr. Aliyar Cyrus Fouladkhah, PhD, MS, MPH, MACE, CFS, CPS
Associate Professor, Tennessee State University
Faculty Director, Public Health Microbiology Laboratory
Founding Director, Public Health Microbiology Foundation
Yale School of Public Health Alumnus

** Funding support from the National Institute of Food and Agriculture, USAID, and Public Health Microbiology Foundation is gratefully acknowledged.*

Workshop Participants & Evaluations

https://publichealthmicrobiology.education/

	სახელი,გვარი	ორგანიზაცია	ტელეფონი	ელ-ფოსტა	ხელმოწერა
1		PDA	595255503		
2		CEO	599554304		
3		NFA	591509511		
4		FSCG	595075624		
5		INVET FEED	593178800		
6			599106699		
7					
8		EVROCERT	599733007		
9			557596145		
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11		599905066	ACDI/VOCA		
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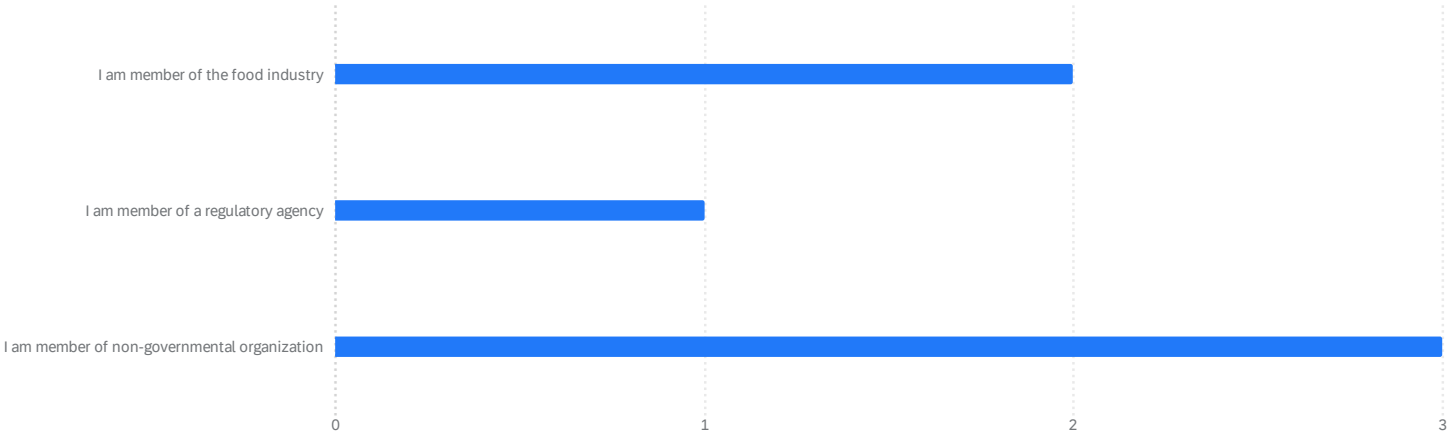
2024 Georgia Food Safety, Climate Change, and Infectious Diseases Workshop / Page 1

Responses: 6

What is your primary career association? 6



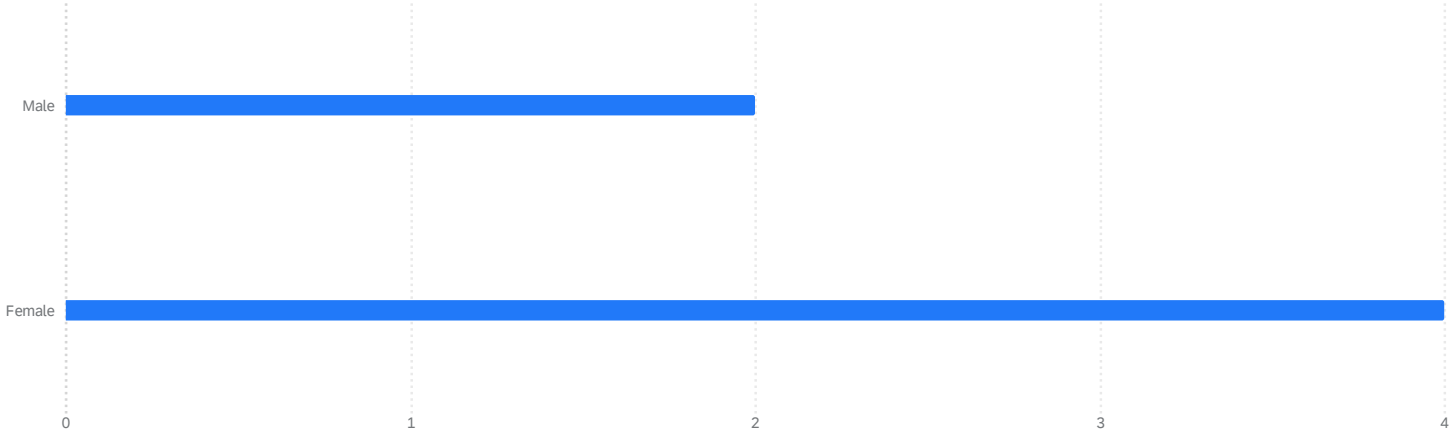
What is your primary career association? 6

Q1 - What is your primary career association?	Percentage	Count
I am member of the food industry	33%	2
I am member of a regulatory agency	17%	1
I am member of non-governmental organization	50%	3

What is your primary career association? 6

What is your primary career association?	Average	Minimum	Maximum	Count
I am member of the food industry	1.00	1.00	1.00	2
I am member of a regulatory agency	2.00	2.00	2.00	1
I am member of non-governmental organization	3.00	3.00	3.00	3

What is your gender? 6



What is your gender? 6

Q2 - What is your gender?	Percentage	Count
Male	33%	2
Female	67%	4

What is your gender? 6

What is your gender?	Average	Minimum	Maximum	Count
Male	1.00	1.00	1.00	2
Female	2.00	2.00	2.00	4

How satisfied are you for attending this workshop: 0=Not satisfied at all; 100=extremely satisfied 6

How satisfied are you for attending this workshop: 0=Not satisfied at all;...	Average	Minimum	Maximum	Count
My instructor is knowledgeable of the subject matter.	100.00	100.00	100.00	6
My instructor communicated effectively.	100.00	100.00	100.00	6
My instructor stimulated my interest in the subject.	100.00	100.00	100.00	6
My instructor answered questions thoroughly.	100.00	100.00	100.00	6
My instructor treated all students with respect.	100.00	100.00	100.00	6
I would recommend this instructor to my friends.	100.00	100.00	100.00	6
My knowledge of the subject increased as a result of this workshop.	100.00	100.00	100.00	6
This workshop made a significant contribution to my career.	100.00	100.00	100.00	6

Please share any information or feedback you would like with the instructor about your experience in this workshop: 6

Please share any information or feedback you would like with the instructor...

Workshop was very productive, I learned a lot about food safety's and it was my pleasure to work with Aliyar.

Information easily understandable, well presented, outstanding personality of instructor

Workshop Certificants

https://publichealthmicrobiology.education/

FSPCA®

FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

CERTIFICATE OF TRAINING

is awarded to

Andria Kalandia

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

Brian Schaneberg, PhD, Director
Institute for Food Safety and Health

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH
ILLINOIS INSTITUTE OF TECHNOLOGY

Gerald Wojtala, Executive Director
International Food Protection Training Institute

ifpti

Steve Mandernach, JD, Executive Director
Association of Food and Drug Officials

AFDO

Certificate # c73ce80e

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is awarded to

Dali Medoidze

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

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delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

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CERTIFICATE OF TRAINING

is awarded to

Givi Gegeshidze

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

Brian Schaneberg, PhD, Director
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CERTIFICATE OF TRAINING

is awarded to

Lana Chvamania

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

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Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

Brian Schaneberg

Brian Schaneberg, PhD, Director
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Steve Mandernach, JD, Executive Director
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Certificate # e1fbefb1

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is awarded to

Lasha Tvalabeishvili

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

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AFDO

Certificate # b27c7644

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is awarded to

Magda Menabde

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

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05/29/2024

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is awarded to

Mariam Lomsanidze

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

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Dr. Aliyar Cyrus Fouladkhah

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Certificate # 32552cac

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FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

CERTIFICATE OF TRAINING

is awarded to

Mikheil Buzariashvili

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

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International Food Protection Training Institute

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Steve Mandernach, JD, Executive Director
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Certificate # f1d6a470

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FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

CERTIFICATE OF TRAINING

is awarded to

Tamar Nozadze

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

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Certificate # 3a7a4aa3

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is awarded to

Tamar Sanikidze

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Dr. Aliyar Cyrus Fouladkhah

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05/29/2024

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Gerald Wojtala, Executive Director
International Food Protection Training Institute

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Steve Mandernach, JD, Executive Director
Association of Food and Drug Officials

AFDO

Certificate # f6271876

FSPCA®

FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

CERTIFICATE OF TRAINING

is awarded to

Tornike Atabegashvili

in recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:

FSPCA Preventive Controls for Human Food

delivered by Lead Instructor

Dr. Aliyar Cyrus Fouladkhah

completed on

05/29/2024

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ILLINOIS INSTITUTE OF TECHNOLOGY

Gerald Wojtala, Executive Director
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Steve Mandernach, JD, Executive Director
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AFDO

Certificate # 2c9b1fe2

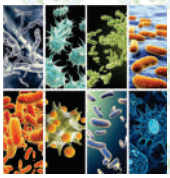
Selected Slides

https://publichealthmicrobiology.education/

Public Health Microbiology in the 21st Century Under the Landscape of Changing Climate

Aliyar Cyrus Fouladkhah, PhD, MPH, MACE, CFS, CPH
Associate Professor, Microbial Food Safety/Epidemiology
Faculty Director, Public Health Microbiology Laboratory
Founding Director, Public Health Microbiology Foundation
Tennessee State University

Presented at:
Washington and Tbilisi USAID ACDI/VOCA program
May 28-30, 2024



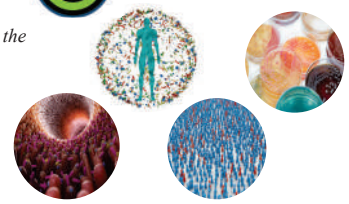
Photos Courtesy: AdobeStock; royalty purchased (standard license) by public health microbiology laboratory and and Climate Reality Leadership Corps

Presentation Content*

Part I: *Brief Introduction to my Program*

Part II: *Global Climate Change Impact*

Part III: *Public Health Microbiology Under the Landscape of Climate Change*



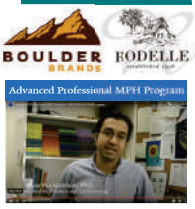
**Excerpts of this section was presented to CDC PHI Fellows and Yale Young Global Scholar Program. Some photo slides that provided by Climate Reality Project is gratefully acknowledged.*

Olivia Ivy Fouladkhah
Born 10-10-2023

- Microbiology and Food Safety, PhD (Colorado State University)
- Applied Statistics and Data Analysis, Graduate Certificate (CSU Statistics Dept.)
- Food Science & Human Nutrition, MS (CSU Food Science Dept.)

Yale SCHOOL OF PUBLIC HEALTH

- Biostatistics and Epidemiology, Advanced Professional MPH
- Food and Drug Regulatory Affairs, Graduate Certificate
- Climate Change and Health, Graduate Certificate



Website: https://publichealth.yale.edu/education/degrees/mph/advanced/
Video: https://www.youtube.com/watch?v=IGVN9Jfoit8

Public Health Microbiology Program
Tennessee State University

Funding sources

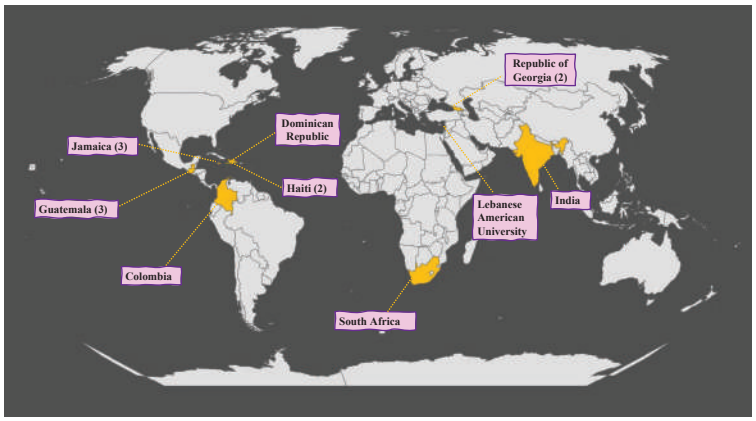
Extramural Funding: >$4.5M since 2015

- USDA-NIFA FSOP: **$299,995** (Role: PD, 2023-2026)
- National Institute of Health: **$33,680** (PD of Sub-award, 2020-21)*
- Pressure BioScience Inc.: **$35,000** (Role: PD, 2019-2024)
- USDA-NIFA CBG: **$350,000** (Role: PD, 2018-2022)
- USDA-NIFA HEC: **$50,000** (Role: PD, 2018-2021)
- USDA-NIFA FSOP: **$165,000** (Role: PD, 2018-2021)
- Pressure BioScience Inc.: **$23,500** (Role: PD, 2017-2019)
- USDA-NIFA FSOP: **$59,750** (Role: PD, 2016-2019)
- Pressure BioScience Inc.: **$9,400** (Role: PD, 2017-2019)
- NIFA FSOP.: **$880,000** (Role: CO-PD, 2019-2023)**
- USDA-NIFA FSOP.: **$1,197,751** (Role: CO-PD, 2015-2020)**
- NIFA CBG.: **$300,000** (Role: CO-PD, 2018-2022)

*Pending account setting and internal administrative approval.
** Sub-awardee of Southern Center Main Awards.

Website: https://publichealthmicrobiology.education/

Website performance: 4/22/2020



Teaching Evaluations Available at: https://publichealthmicrobiology.education/stakeholders-evaluation

Teaching in Tennessee and Internationally

Graduate Course in Policy and Regulations

2022 Student Evaluation:

- *"…Dr. Fouladkhah is easily the nicest professor I have ever had the pleasure of meeting. He seriously cares about you and how you're doing."*
- *""I loved this class it was so interactive and different from any other class I have taken here at TSU!"*

Summary of Students' Evaluation of AGSC 5540- Food Policies and Regulations Course^		
Dr. Aliyar Cyrus Fouladkhah- Sole/Lead Instructor		
Year	Mean Score (5-point hedonic)	University/College/Department Status
2018	5.00/5.00	Ranked #1 in University, College, and Department.
2019	4.55/5.00	Ranked above University, College, and Department means in all 20 evaluation categories.
2020	4.83/5.00	Ranked above University, College, and Department means in all 20 evaluation categories.
2021	4.92/5.00	Ranked above University, College, and Department means in all 20 evaluation categories.
2022	4.86/5.00	Ranked #1 in 7 out of 20 categories compared to all courses of university. Ranked above University, College, & Department means on remaining 13 categories.
^ Complete evaluation data available upon request		

CIFOR Guideline
HACCP
Nutrition Labeling
FSMA PC QI

Typically, 3 to 10 additional enrollment from the Food Industry and Regulatory Agencies via Zoom

Global Health Programs Available at:
https://publichealthmicrobiology.education/global-health-programs

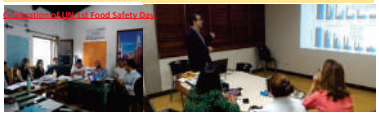
2021, 2022 Jamaica
Food industry Certifications

2020, 2022 (Ministry of Health)
Haiti Government, Fortification with Iron, vitamin b12, and zinc

2019, Philippi Township, Cape Town, South Africa:
HIV Prevention Training

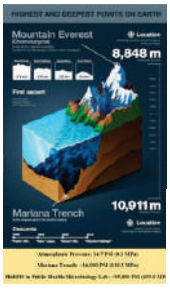
2018, 2020, 2021 Guatemala
Food Safety Training for Food Industry Leadership

2017 Santiago, Dominican Republic
USAID Public Health and Microbiology Training Faculty and Staff of ISA University



Research Responsibility:
1. Elevated Hydrostatic Pressure
2. Bacterial Biofilm
3. Effects of Climate Change on Infectious Diseases

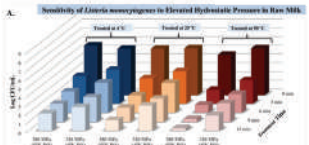
- Elevated Hydrostatics Pressure:
- Hubb880, up to **650 MPa**
- Deepest part of Oceans (Mariana Trench): c. **110 MPa**
- Programable unit Hub 440, 380 MPa
- Controlling the temperature
- Synergism with bacteriocin and bactericidal compounds



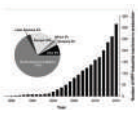
PBI Pressure BioSciences Inc.

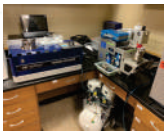
High Pressure Processing, Public Health Microbiology Laboratory

Information about the units: https://ir.pressurebiosciences.com/press-releases/detail/284/pressure-biosciences-announces-commercial-release-of-the

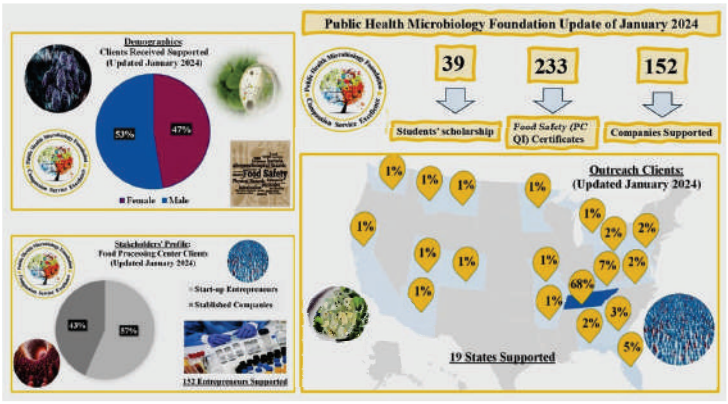


Allison et al., 2018





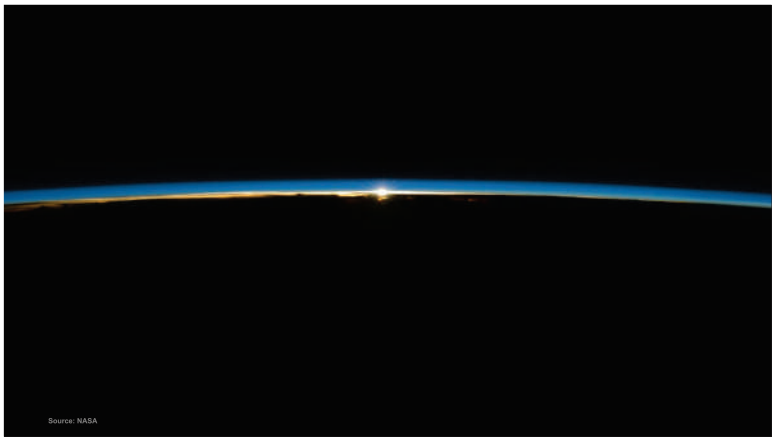
High Pressure Processing, Public Health Microbiology Laboratory



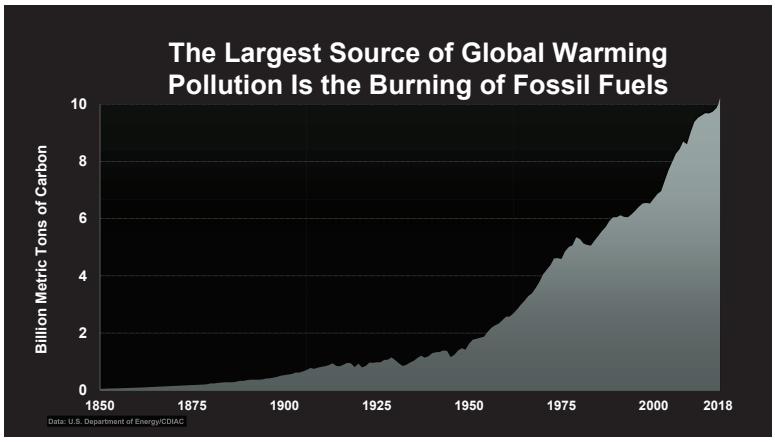
Public Health Microbiology Laboratory

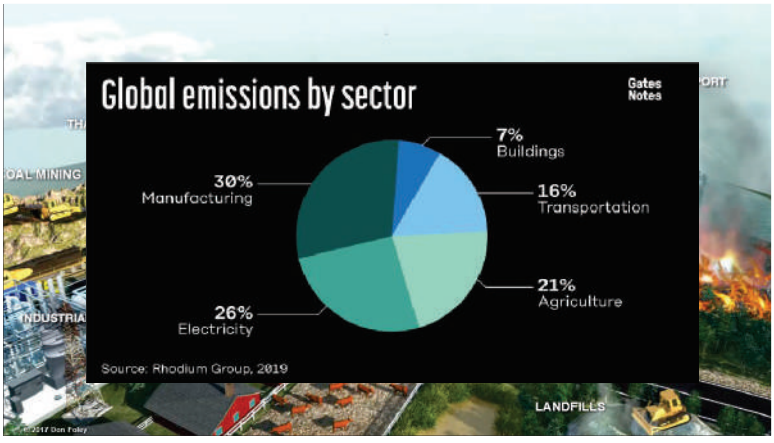
Part II: Global Climate Change in Impact

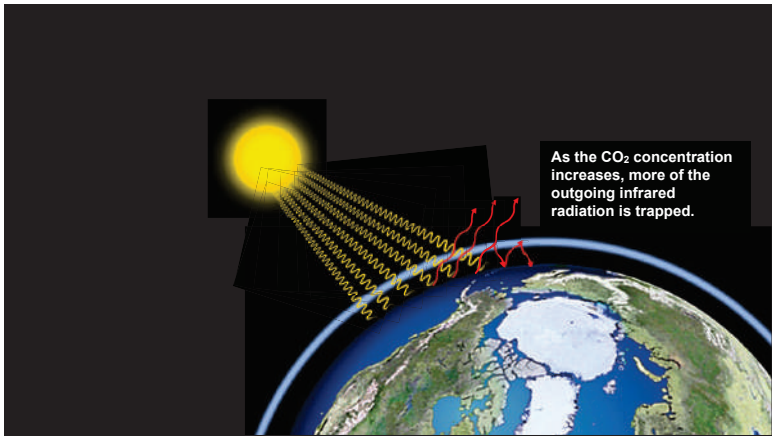
Public Health Microbiology Laboratory
Tennessee State University, Nashville, TN
A. Fouladkhah: Director, Public Health Microbiology Laboratory




We are now spewing 110 million tons of manmade global warming pollution into the thin shell of our atmosphere every 24 hours, as if it were an open sewer.
© Peter Weber/Shutterstock


The Largest Source of Global Warming Pollution Is the Burning of Fossil Fuels
Billion Metric Tons of Carbon
10
8
6
4
2
0
1850
1875
1900
1925
1950
1975
2000
2018
Data: U.S. Department of Energy/CDIAC


Global emissions by sector
Gates Notes
7% Buildings
16% Transportation
21% Agriculture
26% Electricity
30% Manufacturing
Source: Rhodium Group, 2019
LANDFILLS


As the CO_2 concentration increases, more of the outgoing infrared radiation is trapped.

At least 224 locations around the world set all-time heat records in 2018.

The energy trapped by man-made global warming pollution is now "…equivalent to exploding

600,000

First-generation atomic bombs per day 365 days per year."

James Hansen
Former Director, NASA Goddard Institute for Space Studies

The Hottest of All Have Been the Last Seven Years
19 of the 20 Hottest Years on Record Have Occurred Since the Year 2002

2020	2016	2019	2017	2015	2018	2014	2010	2013	2005
2007	2009	2012	2006	2002	2003	2011	1998	2008	2004

Data: NASA/GISS

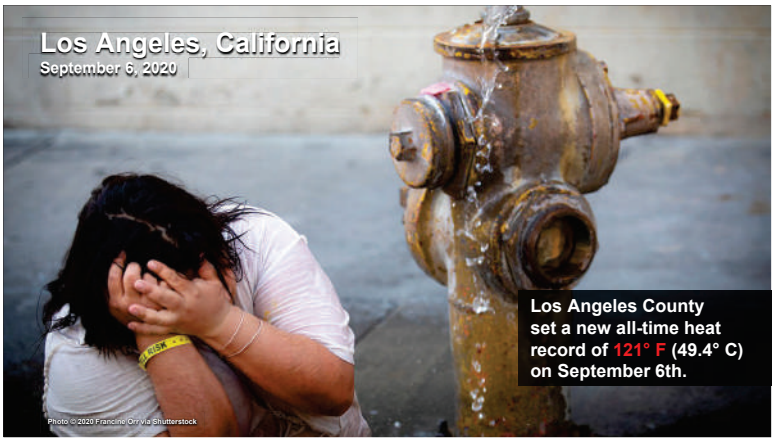
The U.S. Southeast is projected to warm up to 8 °F this century.

Without steep cuts in greenhouse gas emissions, the average temperature in South America could rise 6.7° C by 2100.

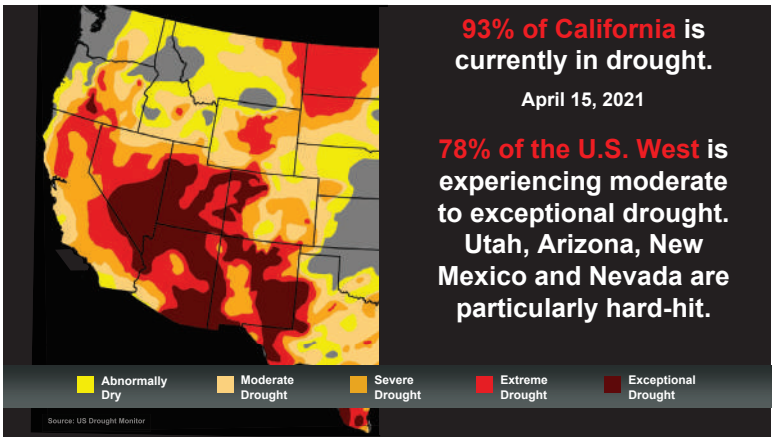
In Central America, the temperature could rise by 4°C.

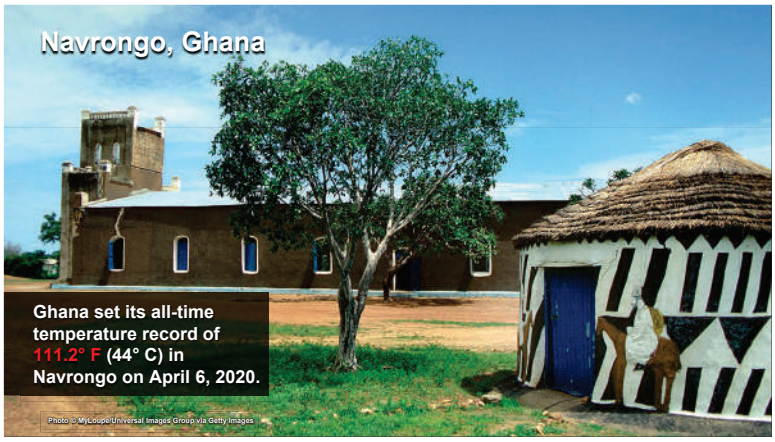
Of the 100 U.S. counties projected to suffer the worst impacts of the climate crisis, 97 are located in the U.S. South.

By 2040, 90% of the population in Colombia and Venezuela may be threatened by extreme heat.


Los Angeles, California
September 6, 2020
Los Angeles County set a new all-time heat record of 121° F (49.4° C) on September 6th.
Photo © 2020 Francine Orr via Shutterstock


Paris, France
August 11, 2020
2020 was Europe's hottest year ever, breaking the record set in 2019.
Photo © 2020 AP Photo/Kamil Zihnioglu


93% of California is currently in drought.
April 15, 2021
78% of the U.S. West is experiencing moderate to exceptional drought. Utah, Arizona, New Mexico and Nevada are particularly hard-hit.
Abnormally Dry
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Source: US Drought Monitor


Navrongo, Ghana
Ghana set its all-time temperature record of 111.2° F (44° C) in Navrongo on April 6, 2020.
Photo © MyLouple/Universal Images Group via Getty Images


Montreal, Canada
July 5, 2018
At least 90 people died in Quebec during the July 2018 heat wave as ambulance services were overwhelmed.
Data: Global News Canada
Photo © 2018 Graham Hughes/The Canadian Press via AP

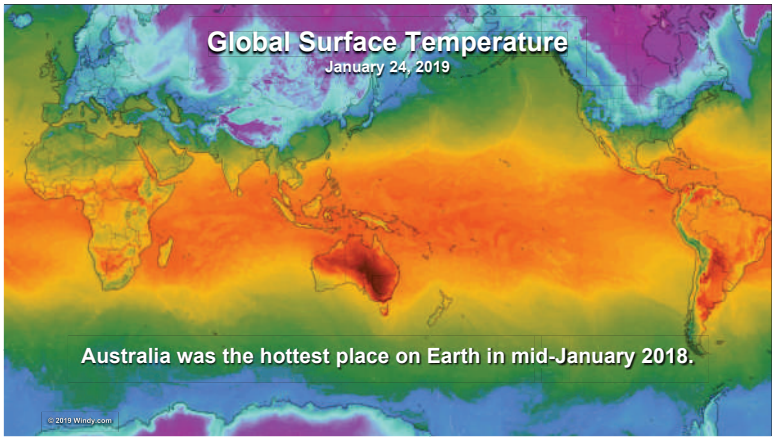

Seoul, South Korea
August 1, 2018
August 1st was the hottest day in Korean history, with temperatures up to 105.8°F (41.0°C).
© 2018 AP Photo/Ahn Young-joon


Vancouver, British Columbia
June 27, 2021
More than a billion seashore animals are believed to have cooked to death during the Pacific Northwest heat wave.
Photo © 2021 Chris Harris / University of British Columbia


Berkshire, England
July 5, 2018
Recycle One More Thing
© Wessex News Agency

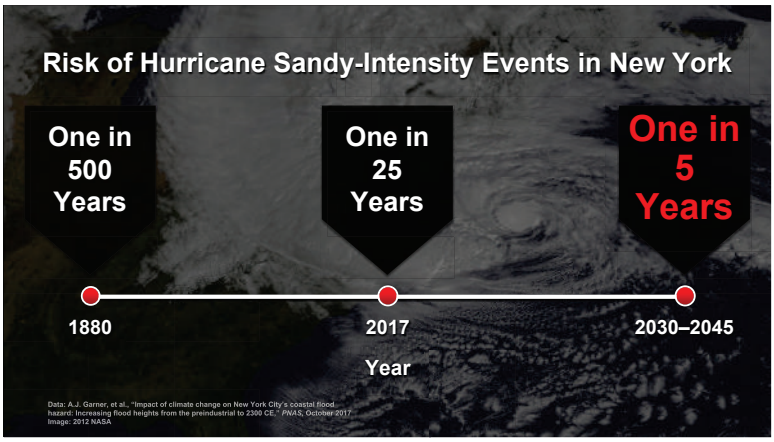
On May 19, 2016
India set a new all-time
high temperature record of

124° F (51° C)

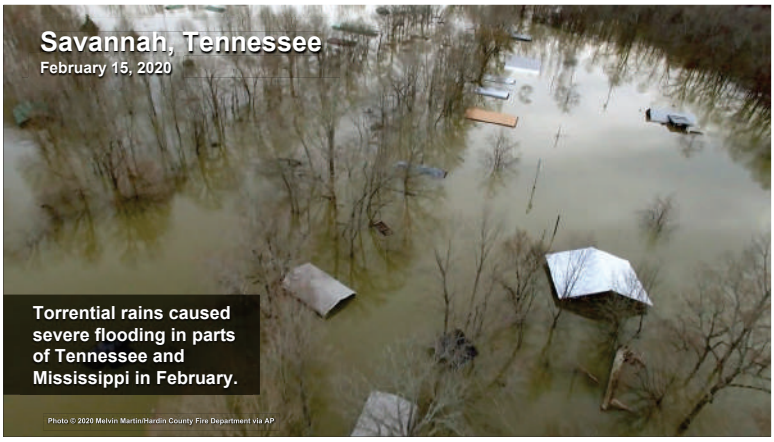


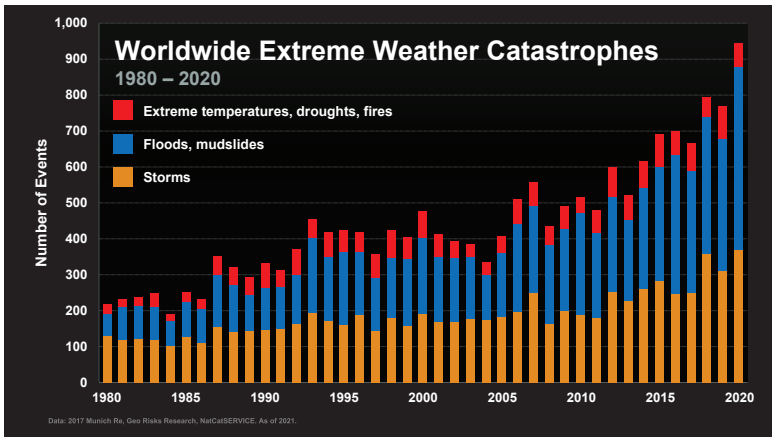
"Unrestrained climate change means we will see many more Harveys in the future."

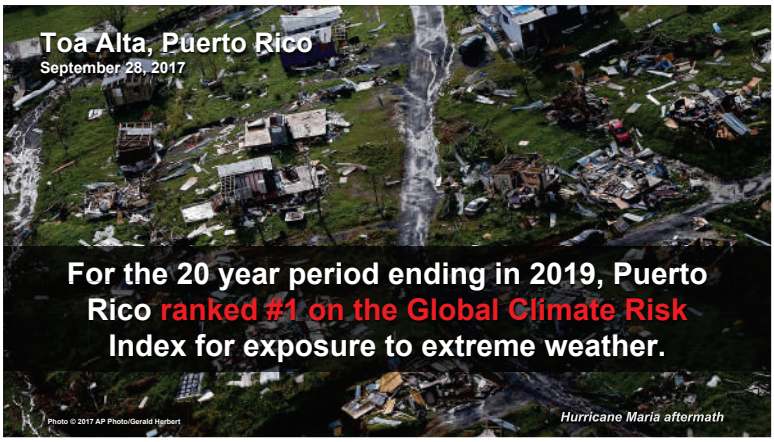
Michael Mann
Director, Earth System Science Center, Penn State
August 2017


Risk of Hurricane Sandy-Intensity Events in New York
One in 500 Years
One in 25 Years
One in 5 Years
1880
2017
2030–2045
Year
Data: A.J. Garner, et al., "Impact of climate change on New York City's coastal flood hazard: Increasing flood heights from the preindustrial to 2300 CE," PNAS, October 2017
Image: 2012 NASA


Nashville, Tennessee
March 3rd, 2021
Immediate vicinity of Tennessee State University. Research Infrastructure of College of Agriculture was severely affected by the storm.


Savannah, Tennessee
February 15, 2020
Torrential rains caused severe flooding in parts of Tennessee and Mississippi in February.
Photo © 2020 Melvin Martin/Hardin County Fire Department via AP


Worldwide Extreme Weather Catastrophes
1980 – 2020
Extreme temperatures, droughts, fires
Floods, mudslides
Storms
Number of Events
1,000
900
800
700
600
500
400
300
200
100
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Data: 2017 Munich Re, Geo Risks Research, NatCatSERVICE. As of 2021.



Projected GDP Shortfalls by 2048 with Unmitigated Warming:

Brazil	17%
Colombia	22%
Chile	27%

Data: Swiss Re


Yangtze River, Chongqing, China
May 8, 2020
2.4 million people in the lower Yangtze river basin were still affected by drought in early 2021.
Photo © 2020 Imaginechina via AP Images


Pocone, Brazil
September 26, 2020
Brazil's drought caused $3 billion in damages in 2020.
Photo © 2020 Buda Mendes/Getty Images


Chennai, India
May 17, 2017
Chennai's state of Tamil Nadu experienced its worst drought in 140 years.
© 2017 Arun Sankar/AFP/Getty Images


Schwüblingsen, Germany
August 22, 2018
2018's droughts in Europe resulted in $3.9 billion in economic losses.
© 2018 Julian Stratenschulte/picture alliance via Getty Images


The Swiss Army had to airlift water to thousands of cows affected by drought.
Rossinière, Switzerland
August 7, 2018
© 2018 Reuters/Denis Balibouse


Gila National Forest, New Mexico
June 24, 2018
The Buzzard fire burned over 50,000 acres.
© U.S. Forest Service/Gila National Forest


Saint-André-de-Corcy, Ain, France
July 23, 2017
© 2017 Konrad K/S/pa AP Images


Edwards, Colorado
April 1, 2018
The fire season in the U.S. west is now 105 days longer than in 1970.
Photo: © 2018 Chris Dillmann/Vail Daily via AP Source: Climate Central Western Wildfires—A Fiery Future, 2016

The 2006 – 2010 drought turned 60% of Syria's fertile land into desert

…and drove 1.5 million people into Syria's already crowded cities

"…the Syrian minister of agriculture
...stated publicly that economic and social fallout from the drought was
'beyond our capacity as a country to deal with.'"

Cable from the U.S. Embassy in Damascus
to the State Department
November 8, 2008

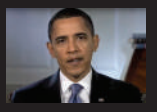
"In future, the climate in large parts of the Middle East and North Africa could… render some regions

uninhabitable,

which will surely contribute to the pressure to migrate."

Jos Lelieveld
The Max Planck Institute for Chemistry
May 2016

United Nation Building Entrance, NY, USA



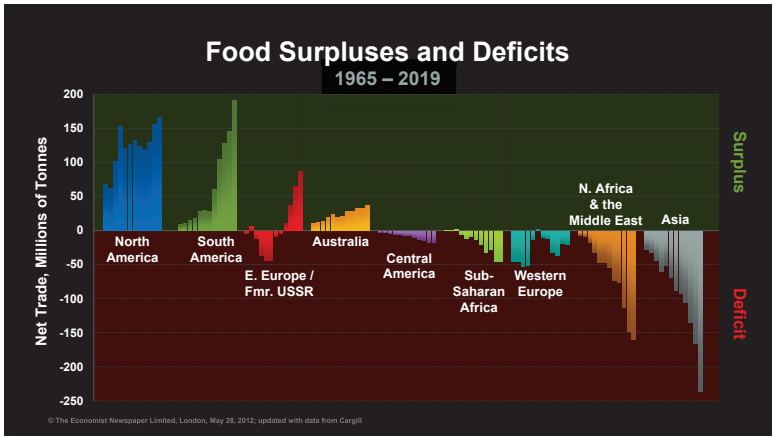
"Human beings are members of a whole,
In creation of one essence and soul.
If one member is afflicted with pain,
Other members uneasy will remain.
If you have no sympathy for human pain,
The name of human you cannot retain."

Poem from S. Shirazi 1210-1291

The heat index in
Bandar Mahshahr reached

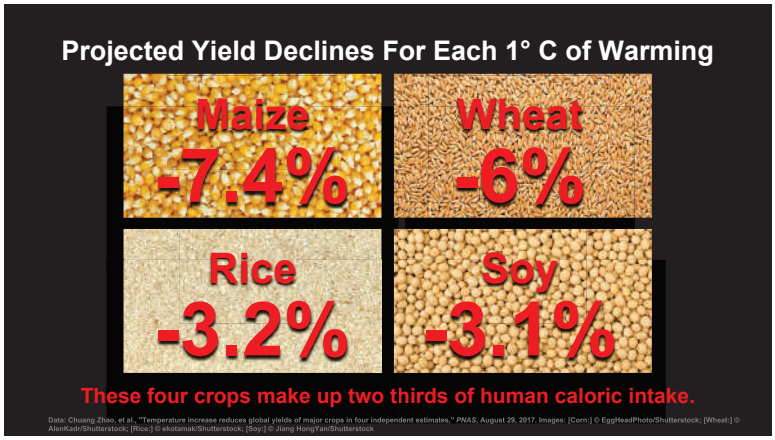
165° F

(74° C) on July 31, 2015



The world could see over
1 billion climate migrants
by the end of this century.

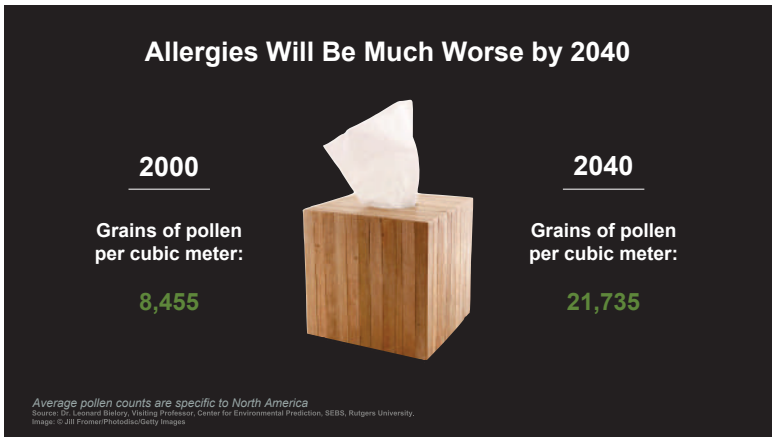
The Lancet Countdown Report
October 2017



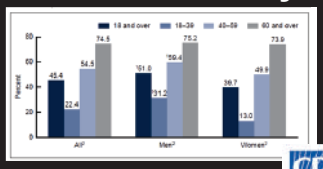

Climate change is projected to lower Georgia's soy yields up to 34% and corn yields by as much as 46% by 2050.
Photo © Christopher Boswell via Shutterstock
Soybean Farm, Georgia


Sea turtle sex is determined by temperature.
At the northern edge of Australia's Great Barrier Reef, 99% of young green sea turtles are now female.
Since 1980, 85% of Jamaica corral reefs have been reduced
Corral reefs 0.1% of Oceans, 25% of ocean lives
Recently, great progress by "coral gardeners"
Source: World Wildlife Fund, 2015
Photo: © 2008 Brocken Inaglory/wikicommons (CC BY-SA 3.0)


Tick-borne diseases affect up to 80% of the world's livestock, with a cost of up to $19 billion per year.
Data: S. Machalaba, WB Karesh, "Vector-borne Diseases: Animals and Patterns," Forum on Microbial Threats, National Academies of Sciences, Engineering and Medicine, 2015
Photo: © 2018 Mohssen Assanimoghaddam/picture-alliance/dpa/AP Images
Namibia


Allergies Will Be Much Worse by 2040
2000
Grains of pollen per cubic meter:
8,455
2040
Grains of pollen per cubic meter:
21,735
Average pollen counts are specific to North America
Source: Dr. Leonard Bielory, Visiting Professor, Center for Environmental Prediction, SEBS, Rutgers University.
Image: © Jill Fromer/Photodisc/Getty Images

We now risk losing up to **50% of all land-based species** in this century



Source: Nicholas Stern, *The Economics of Climate Change*
Photo: © Dirk Ercken/Shutterstock

Most common blood pressure medication (ACE Inhibitor- Captopril) is originally isolated from a snake Venom…

We only have access to non-extinct species.

Bacterial Multiplication

Binary Fission: 20 minutes or less when intrinsic and extrinsic factors are optimal.

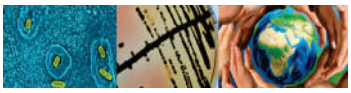
Time	# of Bacteria
0 minutes	1
20 minutes	2
40 minutes	4
1 hour	8
2 hours	64
4 hours	4,096
6 hours	262,144
8 hours	16,777,216
12 hours	68,719,476,736

Bacteria	Estimated Infective Dose*
Salmonella serovars	<10 cells
Shiga toxin-producing *E. coli*	*10 to 100 cells*
Cronobacter sakazakii	10 to 100 cells
Listeria monocytogenes	<1000 cells
Campylobacter spp.	5000 to 10,000 cells
Staphylococcus aureus	>100,000 cells
Vibrio cholerae	1,000,000 cells

Information and photos are modified and adapted from BAM of Food and Drug Administration, BAM Resources of Centers for Disease Control and Prevention. Photo Courtesy: Adobe Stock (student license of photos purchased by the Public Health Microbiology Laboratory)

** Calculated for oral ingestion based on epidemiological data from outbreaks and human feeding trials of volunteers. Data obtained from BAM of Food and Drug Administration 12th edition.*

Public Health Microbiology Laboratory: Education, Research, Outreach, and Technical Assistance: https://publichealthmicrobiology.education/

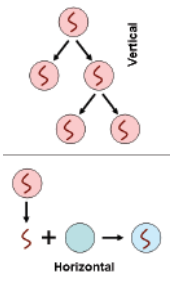


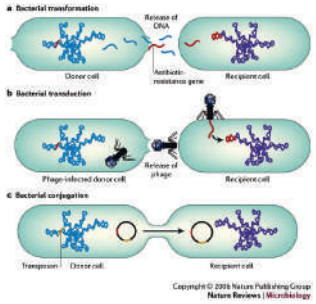
Part III: *Public Health Microbiology Under the Landscape of Climate Change*

Emerging pathogens

Vertical and Horizontal Gene Transfer and Emerging Pathogens

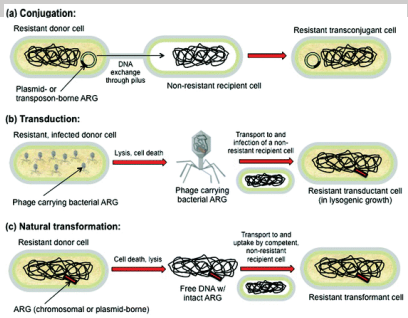
Photo Courtesy: http://www.daviddarling.info/encyclopedia/B/binary_fission.html





Copyright © 2006 Nature Publishing Group
Nature Reviews | Microbiology

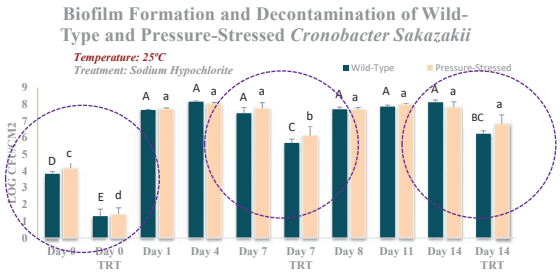
Horizontal Gene Transfer



Donn, 2012

www.publichealthmicrobiology.education

Cronobacter sakazakii
Two outbreaks in Tennessee (1998, Memphis; 2001 Knoxville)



Allison et al., 2021

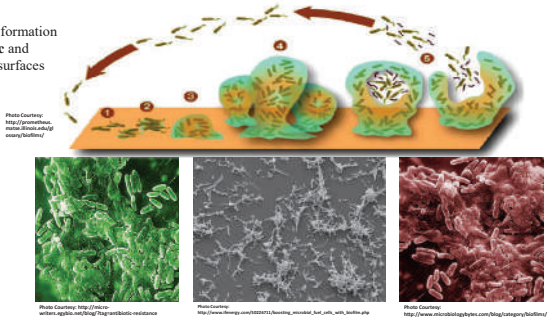
Planktonic cells

One-week-Mature Biofilm

Two-week-Mature Biofilm

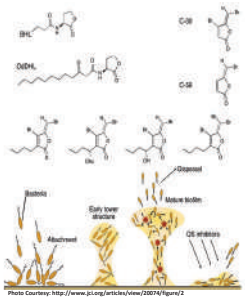
Planktonic cells and Biofilm Communities

Biofilm formation on **biotic** and **abiotic** surfaces



Quorum Sensing and Biofilm formation

Shiga toxin producing *E. coli*, not antibiotic treatment due to Quorum Sensing Concerns



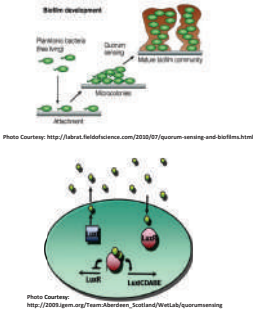


Photo Courtesy: http://labrat.fieldofscience.com/2010/07/quorum-sensing-and-biofilms.html

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

Infectious Diseases is a Moving Target…

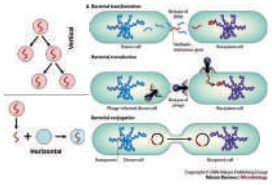
Photo Courtesy: http://www.jci.org/articles/view/20074/figure/2

- 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 (in a typical year, Scallan et all., 2011).

"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



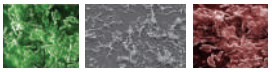


Photo Courtesy: http://www.microbiologybytes.com/blog/category/biofilms/
http://www.ifeneorg.com/GO3671/boosting_microbial_fuel_cells_with_biofilm.php
http://micro-writers.wpglob.net/blog/?tag=antibiotic-resistance

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%).*

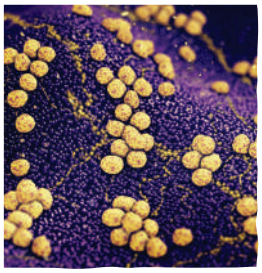
Epidemiology of Foodborne Diseases in the United States

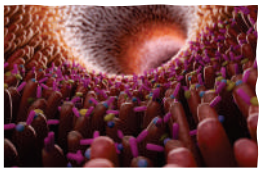
Based on data from 1990s: *(Mead et al., 1999)*

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. **(c. 300,000/year of sepsis)**
- 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)





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

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

National-wide and Regional Foodborne Episodes

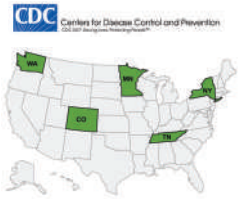
- Centers for Disease Control and Prevention: Foodborne diseases episodes 1998 to 2019.

*Etiological agents for Tennessee episodes:

>200 species of bacteria, viruses, parasites, and chemical toxins.

Total	Outbreaks	Illness	Hospitalization	Deaths
Nation-wide	36,680*	999,364	25,332	1,404
California	1,154	29,642	4,257	123
Tennessee	982	39,005	3,717	104
Maryland	1,043	13,243	4,430	23

Per 100K	Outbreaks	Illness	Hospitalization	Deaths
Nation-wide	11.1	304.5	7.7	0.4
California	2.9	75.0	10.7	0.3
Tennessee	14.4	571.2	54.4	1.5
Maryland	16.9	214.8	7.2	0.4



Pentilla et al., 2024 (Recently completed); Data source: CDC NORS/

CDC Estimates of Food Safety Burden

http://www.cdc.gov/foodborneburden/attribution-image.html#foodborne-illnesses

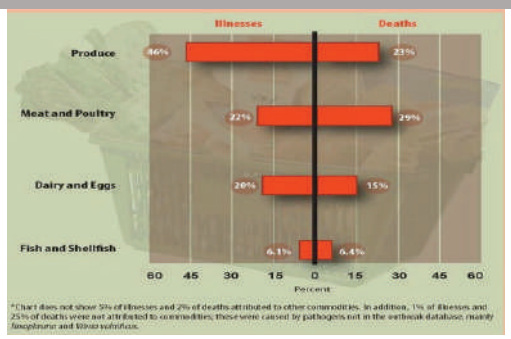
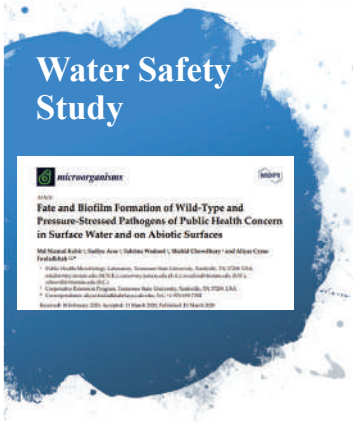


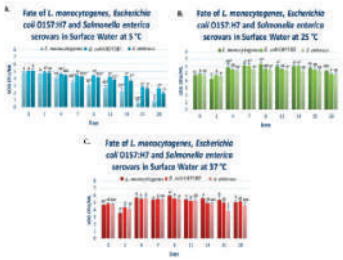
*Chart does not show 5% of illnesses and 2% of deaths attributed to other commodities. In addition, 1% of illnesses and 25% of deaths were not attributed to commodities; these were caused by pathogens not in the outbreak database, mainly Toxoplasma and Vibrio vulnificus.



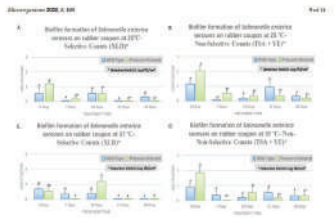
Public Health Burden of Waterborne Disease

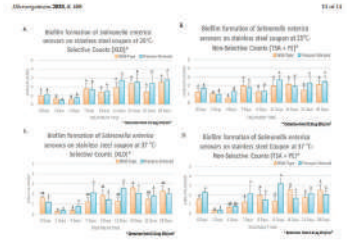
17 waterborne pathogens cause estimated: (Collier et al., 2021)

601,000 **illness**; 118,000 **hospitalization**; 6,630 **deaths**, and cost the economy up to $ 8.77 **billions.**



Water Safety Study-
Biofilm Formation on Abiotic Surfaces





Salmonella serovars (Non-typhoidal)

- **Annual illness (death): 1,027,561 (378) in humans**
- **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)
- **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-spore former		
Atmosphere	Facultative - grows with or without oxygen		

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

Climate Change and Public Health Microbiology

Non-typhoidal *Salmonella enterica* serovars

- **Global death:** 50,000 global death in 2010 (WHO, 2020)
- **Public Health Burden in the U.S.:** >1 million annual cases in 2011 (CDC, 2011)

Climate Change:

- **1 °C increase : 5 to 10% increases in Salmonellosis (WHO, 2010)**
- 2500 to 5000 additional global death
- 50,000 to 100,000 U.S. morbidity

At our current rate (2021 IPCC report)

- >1.5 °C by 2040
- >4.8 °C by 2100

Vibrio spp.

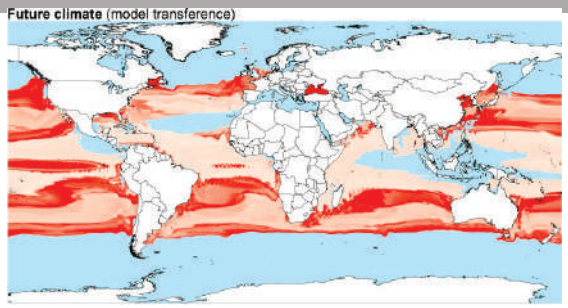
Currently 760,000 global illness/24,000 death per year.

- 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

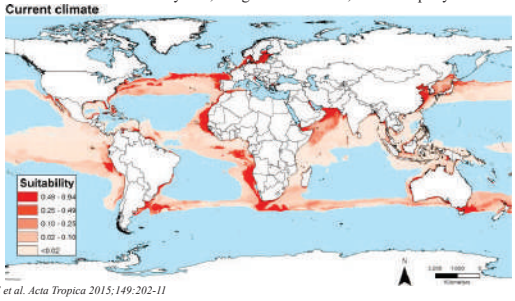
Vibrio cholerae proliferation in sea water: *Business-as-Usual Projection in 2100*



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

Vibrio cholerae proliferation in sea water: *Current Climate*

***Vibrio Cholerae*: currently 760,000 global illness/24,000 death per year**



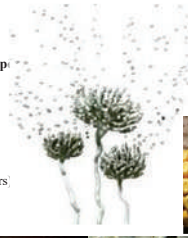
Escobar LE et al. Acta Tropica 2015;149:202-11

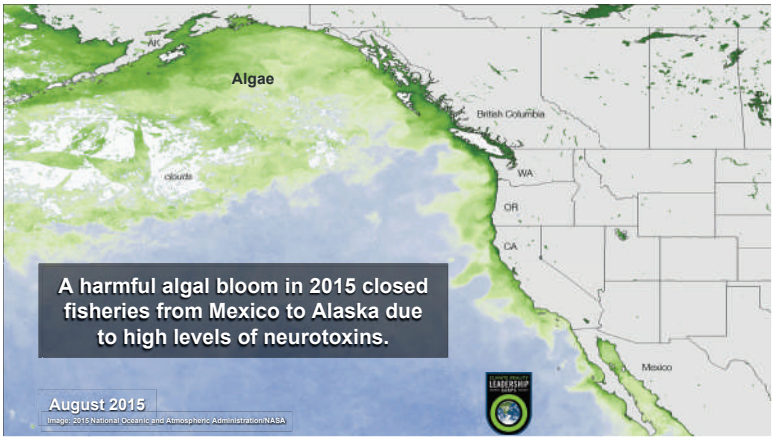
Cases of vibrio-related illness spiked in Washington state after the Northwest heatwave in 2021.

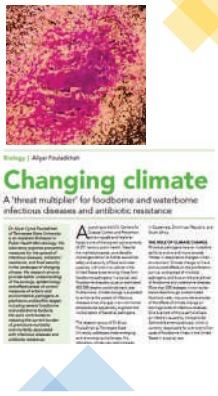
Data: Washington State Department of Health

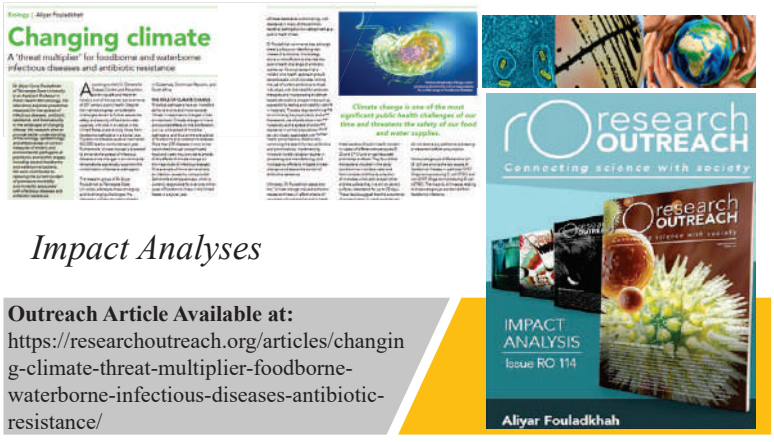
Other Climate-Sensitive Challenges

- **Mycotoxins (At 2°C increase, aflatoxin, North America and Europ**
  - **Aflatoxins:** Peanuts, dried corn (maize), **tree nuts, certain spices**
  - **Ochratoxin A:** Coffee, raisins, wine, cereal grains, certain spices
  - **Patulin:** Fruits (apple and apple juice)
- Attraction of **pests, plant diseases, weeds**
- Changes in **pesticide use pattern is likely**
- Survival and **proliferation of the pathogen** (*e.g.* *Salmonella* serovars)
- **Antibiotic use and antibiotic residue**
- Changes in **migration pathways** (*e.g.* for avian influenza)
- Changes in **carriers and vectors** (*e.g.* Zika virus)
- Changes in **natural ecosystem**
- **Phycotoxins**



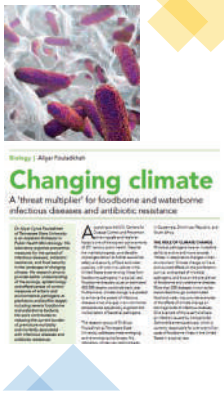


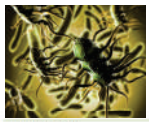




Impact Analyses

Outreach Article Available at:
https://researchoutreach.org/articles/changing-climate-threat-multiplier-foodborne-waterborne-infectious-diseases-antibiotic-resistance/





Biology | Aliyar Fouladkhah

Changing climate

A 'threat multiplier' for foodborne and waterborne infectious diseases and antibiotic resistance

Dr. Aliyar Cyrus Fouladkhah,
Founding Director, Public Health Microbiology Foundation
Associate Professor, Tennessee State University
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Website: https://publichealthmicrobiology.education/

Contributions of members of the Public Health Microbiology laboratory is greatly appreciated. *Funding supports of the program funders are additionally also gratefully acknowledged*

Public Health Microbiology™ Foundation

Dr. Aliyar Cyrus Fouladkhah

CLIMATE REALITY LEADERSHIP CORPS

Photos Courtesy: Adobe Stock, royalty purchased (standard license) by public health microbiology laboratory and Climate Reality Leadership Corps

National and International Importance of Food Safety Modernization Act [5-29-2024]

Aliyar Cyrus Fouladkhah, PhD, MPH, CFS, CPH

Public Health Microbiology Foundation

1

Regulatory Landscape of Food Industry Before FSMA

Very small companies:

Exemption from federal requirements, need to follow state policies

Restaurant operations:

Exemption from federal requirements, need to follow state policies (food code)

Food Safety Inspection Service (FSIS) of USDA:

Meat, Poultry and Egg products, HACCP requirements

Food and Drug Administration of DHHS:

High Risk Foods: Juices, seafood, and shell egg, *HACCP requirements*

Farmers and other food products:

No federal regulation

2

Mandated by FSMA

- Food manufacturing (processors)
- Farmers and growers (producers)
- Transportation, retailers
- Imported foods
- Third party laboratories
- Local, state, and federal agencies
- Foreign governments

Not mandated by FSMA

- FSMA does not directly address sectors under **pre-existing** jurisdictions. HACCP will remain the dominant regulation for:
- Meat, poultry, and egg products (USDA-FSIS)
- Juices, seafood, and shell eggs (DHHA-FDA)
- Very small producers and processors could receive exception from FSMA requirements (**cottage industry**).
- FSMA does not mandate **GM products, antibiotic resistant organisms, organic production, and pesticide and fertilizer** use.

3

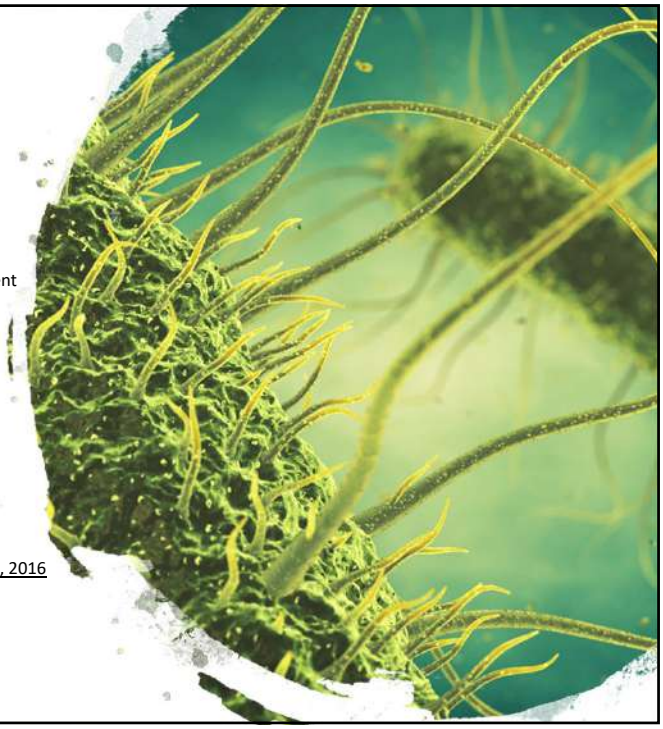
FSMA Implementation Schedule

FSMA was signed into law on **January, 2011**

Regulations were supposed to be finalized within one to two years of enactment (roughly **January 2012 and January 2013**)

Revised implementation dates: (all drafts are currently publicly available)

- **Preventative controls**: FSMA §103(a) and(c): August 30, 2015
- **Foreign supplier verification program**: FSMA §301(a): October 31, 2015
- **Accreditation of third party auditors**: FSMA §307): October 31, 2015
- **Produce safety Rule:** FSMA §105(a): October 31, 2015 [Week 11+ Survey]
- **Sanitary transportation practices for food and feed**: FSMA §111: March 31, 2016
- **Intentional adulteration of food**: FSMA §106(b): May 31, 2016.



4

Produce and Preventive Rules and Land-grant Institutions

- Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption (**Produce Rule**): **Producers**
- Current Good Manufacturing Practice and Hazard Analysis and Risk-Based Preventive Controls for Human Food (**Preventive Rule**): **Processors**

- Large producers and processors
- Small and medium size producers and processors
- Very small (hobbyists) producers and processors (local and cottage industry)

- Many of small and medium size entrepreneur will require assistance from the nations 75 land-grant institution for **safe and economical access to market**.

5

COURSE TYPE	LEAD INSTRUCTOR	COURSE START	WEB ADDRESS TO REGISTER	COST	CONTACT EMAIL	ADDRESS	LANGUAGE	FORMAT
Human Food	Sjoerd Rommers	Nov 29, 2023	Register	EUR 1,510	Contact	Den Bosch Noord-Brabant Netherlands	English	In Person - Live
Human Food	Carmiel Aalberts	Nov 1, 2023	Register	EUR 1,495	Contact	Eemnik Noord Holland Netherlands	Dutch	In Person - Live
Human Food	Dr Dima Faour-Klingbeil	Sep 19, 2023	Register	EUR 1,600	Contact	Hamburg Lower Saxony Germany	English	In Person - Live
Human Food	Dr Dima Faour-Klingbeil	Dec 12, 2023	Register	EUR 1,460	Contact	Hamburg Lower Saxony Germany	English	Virtual - Online, Web Based Live
Human Food	Esther Schenzes	Nov 13, 2023	Register	EUR 1,460	Contact	Virtual Virtual Germany	German	Virtual - Online, Web Based Live
Human Food	Cathy Martin	Sep 22, 2023	Register	USD 658	Contact	No Travel No Travel United States	English	Virtual - Online, Web Based Live
Human Food	Nadia Narine	Sep 25, 2023	Register	CAD 795	Contact	Richmond Hill Virtual Canada	English	Virtual - Online, Web Based Live
Human Food	Vicky Waslewicz	Nov 7, 2023	Register	USD 895	Contact	Pewaukee Wisconsin United States	English	In Person - Live
Human Food	Alexander Keshet	Nov 13, 2023	Register	USD 895	Contact	Hermosa Beach CA United States	English	In Person - Live
Human Food	Dr Dima Faour-Klingbeil	Nov 21, 2023	Register	EUR 850	Contact	Hannover Lower saxony Germany	English	Virtual - Online, Web Based Live
Human Food	David Rosenblatt	Oct 31, 2023	Register	EUR 1,050	Contact	CHICAGO Virtual	English	Virtual - Online, Web

Preventive Control for Human Food: PC QI

- Our course 5-29-2024 to 5-30-2024

Public Health Microbiology™ Foundation

6

FSPCA

FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

CERTIFICATE OF TRAINING

is awarded to

Dr. Minoo Bagheri

In recognition for having successfully completed
the Food Safety Preventive Controls Alliance course:
FSPCA Preventive Controls for Human Food

delivered by Lead Instructor
Dr. Aliyar Cyrus Fouladkhah
completed on
12/08/2021

Jason Wan, Interim Director
Institute for Food Safety and Health

Gerald Wojtala, Executive Director
International Food Protection Training Institute

Steve Mandernach, Executive Director
Association of Food and Drug Officials

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH
ILLINOIS INSTITUTE OF TECHNOLOGY

ifpti

Certificate # 35cb81a6

7

COURSE TYPE	LEAD INSTRUCTOR	COURSE START	WEB ADDRESS TO REGISTER	COST	CONTACT EMAIL	ADDRESS	LANGUAGE	FORMAT
Animal Food	RACHEL MONTGOMERY	Jan 2, 2023	Register	USD 795	Contact	Microbiologist, Live, Interactive Industry-Experienced Lead Instructor Partial Days, Convenient Eastern to Pacific United States	English	Virtual - Online, Web Based Live
Animal Food	RACHEL MONTGOMERY	Dec 5, 2022	Register	USD 795	Contact	Microbiologist, Live, Interactive Industry-Experienced Lead Instructor Partial Days, Convenient Eastern to Pacific United States	English	Virtual - Online, Web Based Live
Animal Food	RACHEL MONTGOMERY	Nov 7, 2022	Register	USD 795	Contact	Microbiologist, Live, Interactive Industry-Experienced Lead Instructor Partial Days, Convenient Eastern to Pacific Time United States	English	Virtual - Online, Web Based Live
Animal Food	Bita Saidi	Dec 21, 2022	Register	USD 795	Contact	Live-Virtual Live-Virtual United States	English	Virtual - Online, Web Based Live
Animal Food	Bita Saidi	Nov 2, 2022	Register	USD 795	Contact	Live-Virtual Live-Virtual United States	English	Virtual - Online, Web Based Live
Animal Food	RACHEL MONTGOMERY	Feb 6, 2023	Register	USD 795	Contact	Microbiologist, Live, Interactive, Industry-Experienced Lead Instructor Partial Days Convenient Eastern to Pacific United States	English	Virtual - Online, Web Based Live
Animal Food	RACHEL MONTGOMERY	May 8, 2023	Register	USD 795	Contact	Microbiologist, Live, Interactive, Industry-Experienced Lead Instructor Partial Days Convenient Eastern to Pacific United States	English	Virtual - Online, Web Based Live

Animal Food PC QI:
https://fspca.force.com/FSPCA/s/courselist?language=en_US

8

Contents of a Food Safety Plan

Required

- Hazard analysis
- Preventive controls*
  - Process, food allergen, sanitation, supply-chain and other
  - Recall plan*
- Procedures for monitoring, corrective action and verification*

Useful

- Facility overview and Food Safety Team
- Product description
- Flow diagram
- Process description

* Required when a hazard requiring a preventive control is identified

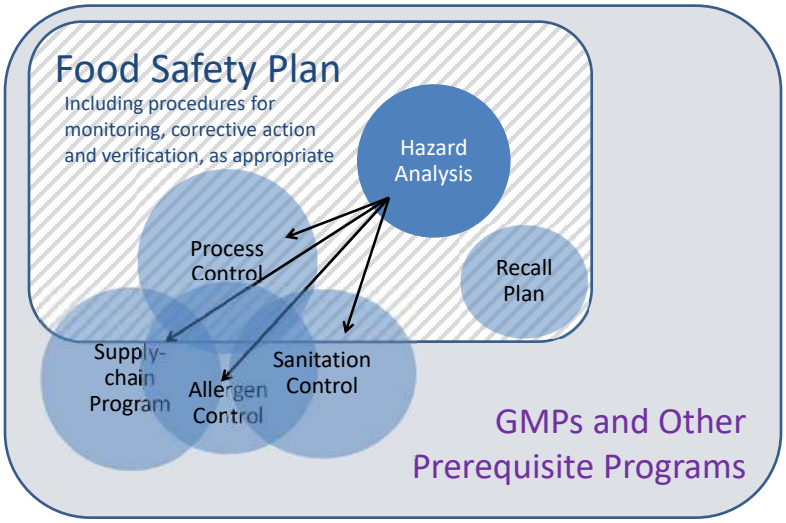
9

What's New in a Food Safety Plan

Element	HACCP Plan	Added in Food Safety Plan
Hazard analysis	Biological, chemical, physical	Chemical hazards to include radiological; consider economically motivated hazards
Preventive controls	CCPs for processes	Process CCPs + controls at other points that are not CCPs
Parameters and values	Critical limits	Parameters and minimum/maximum values (= critical limits for process controls)
Monitoring	Required for CCPs	Required as appropriate for other preventive controls
Corrective actions or corrections	Corrective actions	Corrective actions or corrections, as appropriate
Verification	For process controls	As appropriate for all preventive controls; supplier verification required when supplier controls a hazard
Records	For process controls	As appropriate for all preventive controls
Recall plan	Not required in the plan	Required when a hazard requiring a preventive control is identified

10

Preventive Food Safety Systems



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Photos courtesy: Adobe Stock, royalty (standard license) purchased by public health microbiology laboratory

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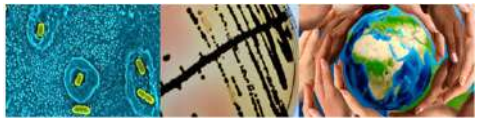


Transboundary infectious disease and microbial food safety

Foodborne Diseases of Public Health Importance and Additional Transboundary Disease

Washington and Tbilisi USAID ACDI/VOCA program

May 28-30, 2024

Aliyar Cyrus Fouladkhah, PhD, MS, MPH, CFS, CPH

Faculty Director, Public Health Microbiology Laboratory

1

One Health: Interactions between people, animals, plants, and our environment

(1) **Human Populations**: Growth and expansion into new geographic regions.

(2) **Planetary Health:** Climate changes, land use, such as deforestation and intensive farming

(3) **Animals, and Animal Products**: international travel and trade

Results in:

Spread of **existing** or known (endemic) and new or **emerging** (new), or **re-emerging infectious disease**.

One Health is gaining recognition in the United States and globally as an effective way to fight health issues at the **human-animal-environment** interface.

An estimated **60% of known infectious diseases** and up to **75% of new or emerging infectious diseases** are zoonotic in origin*

Most Common One Health Issues:

- Rabies; *Salmonella* infection; West Nile virus infection; Q Fever (*Coxiella burnetii*); Anthrax; Brucellosis; Lyme disease; Ringworm; Ebola

*Source: https://www.cdc.gov/onehealth/index.html and * Salyer, 2017*

2

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**

[Sporadic to pandemic to Endemic, like HIV 1959 in Congo]

3

Rift Valley Fever

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

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:

-**Animals**: Abortion and death in neonates (asymptomatic adults)

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

Typically, one person touch his/her face upto 16 times per hour

[Infection control of hands in some culture…]

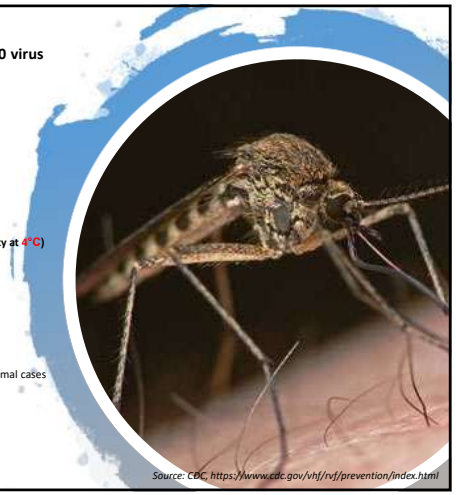
4

One virus: 1×10^{-17} **kg**

I Kg= 100,000,000,000,000,000 virus

I kg =2.2 lb

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 **relatively stable in environment (>30 days without loss of infectivity at 4°C)**
- Could be in activated by various chemical sanitizers

[not like Bacterial biofilms …]

Recent Outbreaks:

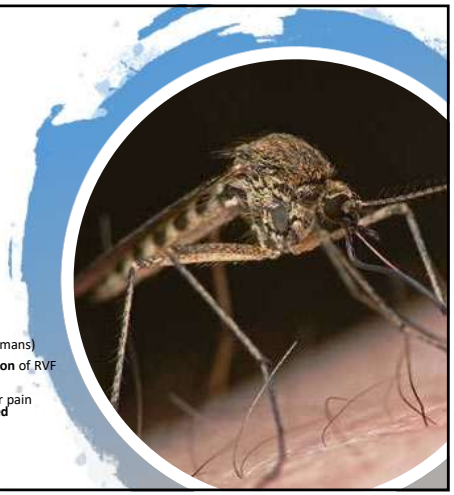
- **Niger, 2016:** 33 deaths
- **Uganda, 2016:** 3-5 confirmed cases
- **South Africa and Namibia: 2009-2011:** 25 human death, >14,000 confirmed animal cases

[infection control: N95, KN95, Surgical masks …]

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

5

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
- Mostly **self-limiting** requiring over-the-counter medication for pain management. **Around 1% mortality**. There is no **FDA approved treatment.**

6

Tularemia

- **Bacterial diseases** caused by: *Francisella tularensis*

(South-central and western parts of state and rural areas)

- **Symptoms**
- **Sheep, young pigs, horses, dogs, cats**:
  - -Sudden fever
  - -Lethargy
  - -Stiffness
  - -Prostration
  - -Death

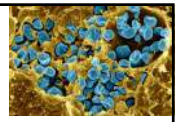
- **Wildlife:**
  - -Common in wildlife find dead
  - -Rabbits behave strangely
- **Cattle, older pigs resistant**

- **Humans**
- caused by ingestion of organism in **contaminated food** (undercooked meat).
- Could cause **skin** complication and **systematic infections**
- Could be **30 to 60% lethal** if untreated

7

Source, CDC

Tularemia



- Infection could occur in Human:

-Tick, deer, and fly bites
-Skin contact with infected animals or
-Ingestion of contaminated water or food
-Inhalation of contaminated aerosols or
-Agricultural dusts
-Drinking contaminated water
-Laboratory exposure

- **Person-to-person transmission not documented**

- In the United States, naturally occurring infections reported from **all states** except **Hawaii**

8

Tularemia

- Bacterium is very stable and capable of forming biofilm
- In the US, 274 cases in 2019 with 0.1 in 100,000 people prevalence.
- **Could be aerosolized** with **low infective dose** via inhalation [unlike *Campylobacter* …]
- Case fatality: **30-60% (untreated)**
- **Antibiotics effective**, if given early or before exposure [Sepsis]
- **Vaccine:**
  - **-For high-risk individuals**
  - **-Unknown efficacy against inhalational tularemia**

Other precautions to avoid Tularemia:

- Use of **insect repellent**
- **Wearing gloves when handling sick or dead animals**
- **Avoiding mowing over dead animals**

Source: cdc

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Bacterial Multiplication

Binary Fission: 20 minutes or less when intrinsic and extrinsic factors are optimal.

Time	# of Bacteria
0 minutes	1
20 minutes	2
40 minutes	4
1 hour	8
2 hours	64
4 hours	4,096
6 hours	262,144
8 hours	16,777,216
12 hours	68,719,476,736

Bacteria	Estimated Infective Dose*
Salmonella serovars	<10 cells
Shiga toxin-producing *E. coli*	10 to 100 cells
Cronobacter sakazakii	10 to 100 cells
Listeria monocytogenes	<1000 cells
Campylobacter spp.	5000 to 10,000 cells
Staphylococcus aureus	>100,000 cells
Vibrio cholerae	1,000,000 cells

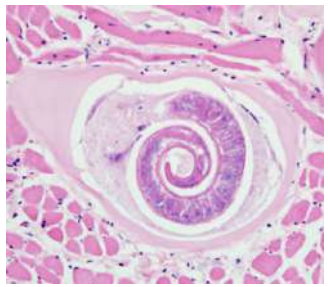
Public Health Microbiology Laboratory: Education, Research, Outreach, and Technical Assistance: https://publichealthmicrobiology.education/

10

Trichinellosis (also known as Trichinosis)

Photos courtesy for Animal and Plant Health Diseases

Photos courtesy for Human Health Diseases. Public Health Image Library



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

-Wild carnivorous **animals** such as bear or cougar

-Omnivorous **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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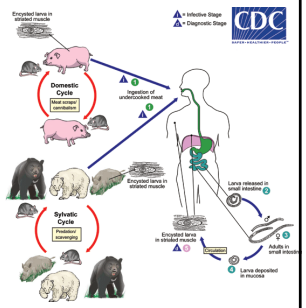
Trichinellosis (also known as Trichinosis)

- **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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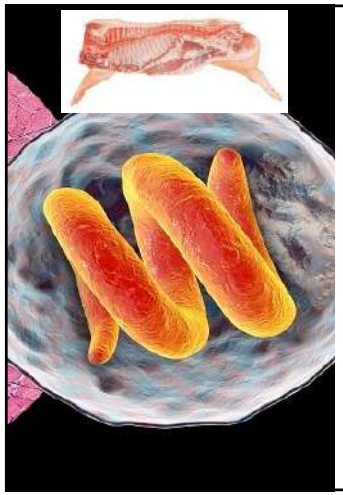

Trichinellosis (also known as Trichinosis)

Prevention:

- For **Ground Meat** (including wild game, excluding poultry)
  Cook to at least **160° F (71° C)** [Variations available, will discuss in Food Code Talk]
  [TN Variance Committee]
- For All **Wild Game** (whole cuts and ground)
  Cook to at least **160° F (71° C).** **[Intact and nonintact meat, around 75% carcass]**

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. **[Extension program, Extension Agents]**

- **Freezing: [not effective against most viruses and bacteria]**
- **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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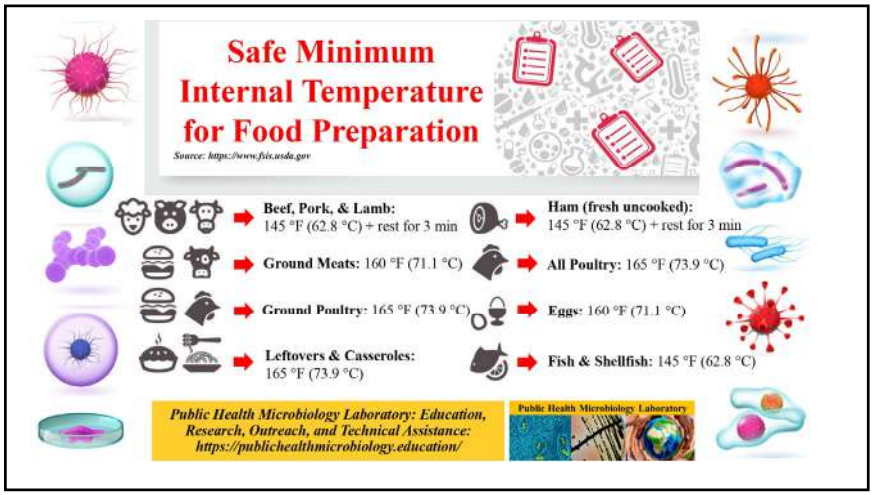

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Zoonotic Infectious Diseases in Poultry

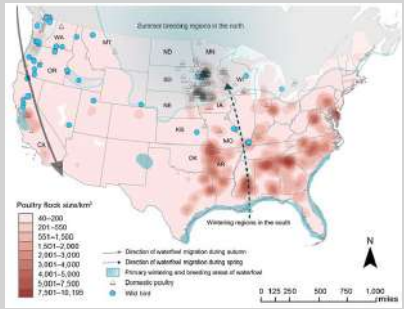
- New Castle Diseases
- Avian Influenza in Eastern Hemisphere
- Avian Influenza in Western Hemisphere
- Role of land-grant Universities and Cooperative Extension Program

[Great job opportunities …]

[Extension, funded by government agencies]

Offices in >50 counts of 95 TN counties

HPAI 2014-2019, United States



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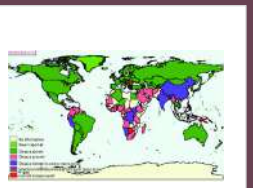

Source: Merck Veterinary Manual

Newcastle Disease- Etiology

- **Viral disease**
- It is a **worldwide problem**
- **Domestic poultry and other bird species**
- **Endemic in poultry**:
  Most of **Asia, Africa**, and some countries of **North and South America**.
- **Clinical signs**:
- Acute respiratory disease
- Nervous manifestations,
- Diarrhea
- Occurrence of the disease in the U.S. **reportable** and may result in **trade restrictions.**
- **Infected birds shed virus:**
  - In exhaled air
  - Respiratory discharges
  - Fecal matter

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Newcastle Disease- Epidemiology

Spread of Disease:

- Movement of infected birds
- Transfer of virus in **infective fecal matters** by the movement of people and
- contaminated equipment or litter

Epidemiology in the USA and Canada:

- Are free of pathogenic strains in poultry processing (eradicated).
- Maintain that status with **surveillance**, **import restrictions** and **eradication** by destroying infected poultry.
- NDV strains of **low virulence** are prevalent in poultry and **wild birds, especially waterfowl.**

Current Concern:

- **Cormorants, pigeons, and imported psittacine** species are more commonly infected with virulent (pathogenic) NDV and have also been sources of vNDV infections of poultry.

Source: Merck Veterinary Manual

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Newcastle Disease- Symptoms

- **Incubation period** in birds: 2-15 days (**life expectancy** of broiler chicken about **1.5 months**, in nature **1.5 years** or more)

Symptoms in birds:

- Drop in egg production
- Neurological damage
- GI signs,
- Respiratory distress
- Numerous deaths within 24-48 hours

- Within a flock, deaths continue for 7-10 days
- **Morbidity 100%, mortality 90%** *(concentration and genetic similarity)*
- Not a **major Zoonotic disease**

Symptoms in humans (poultry processing plants workers, public health workers):

Mild eye complications (Conjunctivitis)

Flu-like symptoms

Mostly self-limiting

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Newcastle Disease- Preventive measure

- No vaccines available for humans

[Self-limiting, average cost of new vaccine/drug development > $350 M]

[New Drug vs. New Food Additives> GRAS list talk]

- In Animals, ND vaccines **do not provide sterile immunity** (complete protection), and in many areas of the world vaccines are used to **prevent losses from sickness and death**.
- The **vaccinated birds will shed if infected** with vNDV

- **Preventive measure:**
- Isolation and
- Depopulation of the infected birds

Source: Merck Veterinary Manual

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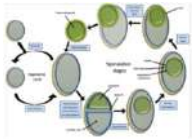
Anthrax

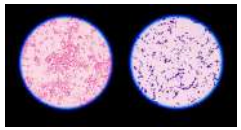
- Causative agent: *Bacillus anthracis*
- A **Gram-positive** and **spore-forming** bacteria
- Can be found as a spore in the **soil worldwide**
- Spores **viable** for **decades in soil**
- **In the US**: Dakotas, northwest Minnesota, Texas, and Nevada
- Common in parts of Africa, Asia, and Middle East
- In Human:
  - Skin
  - Intestine
  - Inhalation
- Animal disease
  - Septicemia and rapid death

Communicable and Non-Communicable Diseases

Gram-Staining

Developed by: Danish Scientist, Dr. Hans Christian Gram (1884)





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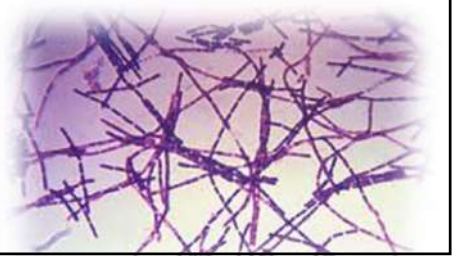
Anthrax

- Spores highly infective
- Remain effective during aerosolization
- Low lethal dose
- High mortality
- Person-to-person transmission rare
- **Symptoms** begin between **one day** and **two months** after the infection



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Anthrax- Control and Treatment

- **Four types in human:** Cutaneous (skin); Inhalation; Gastrointestinal; Injection anthrax
- **Vaccine for livestock annually to prevent**
- Personal Protective Equipment
  - When handling sick animals
- Disinfection:
  - **Sporicidal agents:** 5% formaldehyde, 2% glutaraldehyde, 10% sodium hydroxide
  - **Sterilization:** chlorine dioxide, formaldehyde gas, heating to 121°C for at least 30 minutes
- **Antibiotics:** effective for humans when **prescribed early**
- **Zoonotic Disease**

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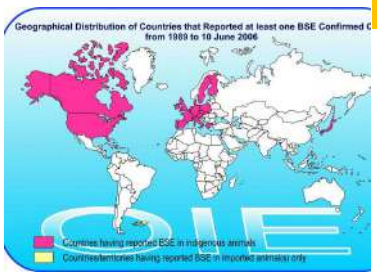
BSE- Bovine Spongiform Encephalopathy

Commonly known as Mad Cow Disease

- 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 (sanitization very difficult)**
- **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

Source: CDC https://www.cdc.gov/prions/index.html

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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, 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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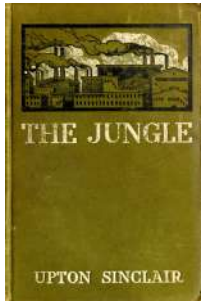
Foot-and-Mouth In the United States

- 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 later** 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**

OIE
WORLD ORGANISATION FOR ANIMAL HEALTH

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
- **Vaccines available**: **Difficulty** but must be matched to the specific **type** and **subtype** of virus causing the outbreak
- Vaccination, usually used to slow spread (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
  - >500 million chickens (not a concern in poultry)
- **Humans rarely infected**
- FMD is not a public health or food safety threat.
- Huge economic impact
- Commercially produced meat, milk and dairy products would be **safe to consume** in an **FMD outbreak**.

Hand, foot, and mouth disease

- **(Not the same virus, similar symptoms)** 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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Foodborne Diseases of Public Health Importance

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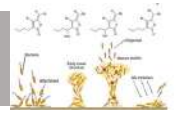
Infectious Diseases in Animals and Human is a Moving Target…



- 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

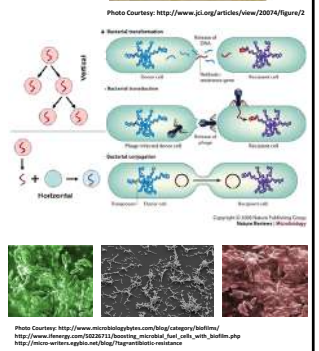


Photo Courtesy: http://www.jci.org/articles/view/20074/figure/2

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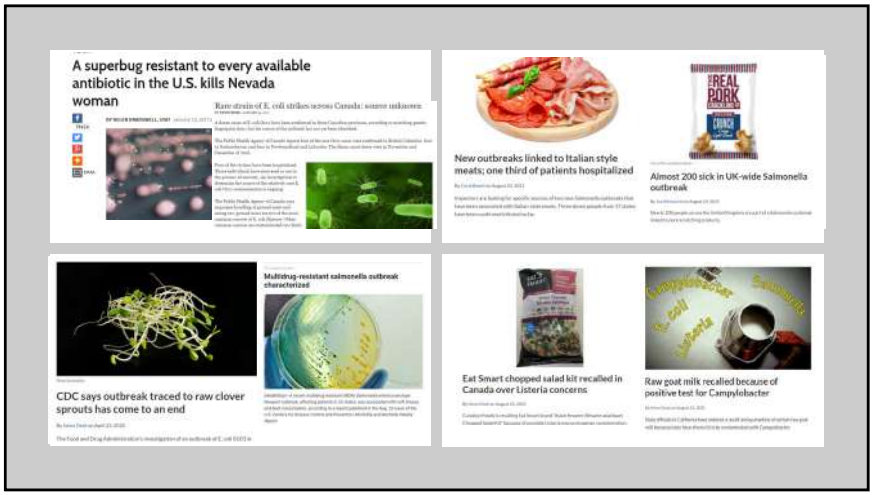

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Are these outbreaks associated with corporates and lager manufactures?

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Prevalence of Pathogens in Medium-sized Poultry Operations

- 200–300 ft houses, 3000 to 5000 birds, conventional operation

(Alali et al., 2010)

	Salmonella serovars
Fecal samples (n=420)	38.8%
Feed (n=140)	27.5%

- Total of 135 sample from commercial free-range chicken producers

(Bailey et al., 2005)

	Salmonella serovars
Chicken Carcasses in Operation 1	64%
Chicken Carcasses in Operation 2	31%

Alali et al., 2010, J Foodborne Pathogens and Diseases; Bailey et al., 2005, J Food Protection

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Prevalence of Pathogens in Small Poultry Farms

- Study of 60 Small poultry slaughterhouses (fewer than 200 birds slaughtered per day)

Sampling sites	*Salmonella* serovars *(Albany, Hadar, Indiana, and Enteritidis sub-species)*
Carcasses after slaughter	42%
Utensils	23.1%
Storage freezers and refrigerators	71.4%

- The Study concluded "*The widespread occurrence of Salmonella in small slaughterhouses reinforces the need for implementation of effective control measures…*"

Terumi et al., 2000, Journal of Food Protection

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

- *Salmonella* serovars
- *Staphylococcus aureus*
- *Campylobacter* spp.
- *Bacillus cereus*
- Shiga Toxin-Producing *Escherichia coli* (STEC)
- *Vibrio* spp.
- *Yersinia enterocolitica*
- *Streptococcus* spp.
- *Shigella* spp.
- *Listeria monocytogenes*
- *Mycobacterium bovis*
- *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-spore former		
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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Salmonella serovars

- **Carriers**: **Reptiles** (turtles, lizards, and snakes); **Amphibians** (frogs and toads); **Poultry** (chicks, chickens, ducklings, ducks, geese, and turkeys); **Other birds** (parakeets, parrots, and wild birds); **Rodents** (mice, rats, hamsters, and guinea pigs); Other **small mammals** (hedgehogs); **Farm animals** (goats, calves, cows, sheep, and pigs); **Dogs; Cats; Horses. [Pretty much ubiquitous!]**
- **Dogs and cats** that become ill from *Salmonella* infection generally will have **diarrhea** that may contain blood or mucus
- Some cats do not have diarrhea, but will have a **decreased appetite, fever, and excess salivation**.

Prevention:

- **Minimizing direct contact**, **washing hands**, and **cleaning up after the pets** could minimize the risk of transmission from infected animals to human.

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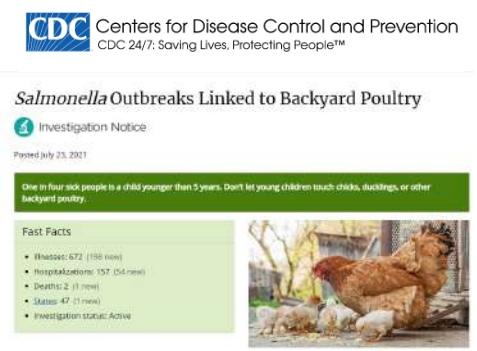
Salmonella serovars



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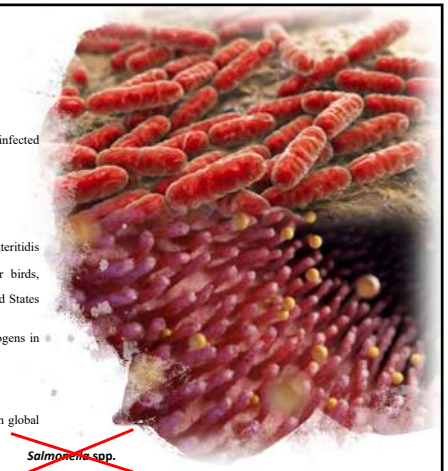
Nomenclature and Epidemiology of *Salmonella*

(Asefaw et al., 2023)



•*Salmonella* was first isolated in 1855 from the gastrointestinal area of an infected animal.

Nomenclature of *Salmonella* has been subject to major changes:
- Only two species (i.e., *Salmonella enterica* and *Salmonella bongori*)
- *Salmonella enterica* has six sub-species and more than 2,600 serovars

•*Salmonella* could cause two distinctly different diseases:

Nontyphoidal *Salmonella* (e.g. Typhimurium, Newport, and Enteritidis serovars)
- •Humans and other animals (Reptiles, amphibians, poultry and other birds, rodents, other small mammals, farm animals, dogs; cats; Horses)
- •>1 million cases of nontyphoidal Salmonellosis in Humans in the United States in a typical year
- •94% of cases associated with contaminated foods
- •Largest public health burden (DALY) among the major foodborne pathogens in the United States
- •Hospitalization: 27.2%

Typhoidal *Salmonella* (e.g. Paratyphi, Sendai, and Typhi)
- •Adapted exclusively to humans as their host
- •1821 cases of typhoidal *Salmonella* occur in the United States (>27 million global cases)
- •Majority of cases associated with travel abroad
- •Hospitalization: 75.7%

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Staphylococcus aureus

Foodborne Diseases
- Infection
- Intoxication
- Toxico-infection

- **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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Staphylococcus aureus

- **Methicillin-resistant *Staphylococcus aureus* (MRSA)** a major concern for animal and human health.
- Humans working closely in **animal feeding operations** are in elevated risk of exposure to this pathogen particularly the **antibiotic resistant phenotypes**
- A **contagious bacterium** responsible for vast majority of environmental **Mastitis in dairy** operations.
- Cause of "bumblefoot" in chickens
- A major pathogen of farm rabbits

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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-spore former		
Atmosphere	3-5% oxygen optimum		

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

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Campylobacter spp.

- Bacterium exist in GI track of **many healthy farm and companion** animals.
- **Dogs six week and younger** are prone to Campylobacteriosis with symptoms:
  - -Fever
  - -Vomiting
  - -Loss of appetite
  - -Enlarged lymph nodes
- **Staying in kennels** that increases the **exposure to fecal matter** and contact with contaminated food and water are main sources of disease in dogs.

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Bacillus cereus

- **Annual illness (death): 63,400 (0)**
- Produces spores and toxins and extensive growth is required for illness
- **Primary source**: soil and GI track
- **Transmitted** by: rice and starchy foods, meats, vegetables, milk products, sauces
- Contributing factors: **temperature abuse**

Growth parameters	Minimum	Optimum	Maximum
Temperature	39°F (4°C)	82-95° F (28-35°C)	131°F (55°C)
pH	4.3	6.0-7.0	9.3
a_w	0.92	-	-
Other	Spore former; toxin is heat stable		
Atmosphere	Facultative – grows with or without oxygen		

Sources: Seafood Hazards Guide, ICMSF 1995, Bad Bug Book, Scallan et al. 2011, and FSOCA

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Bacillus cereus

- Some studies indicate the bacterium could behave as an agent of mammary gland **infection in cows** and **goats** thus causing **mastitis.**
- Cases of **food poisoning in dogs and cats** had also been reported, although not very frequent in nature.
- Many agricultural animals carry the **bacterium in their intestinal area** without symptoms.

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Shiga Toxin-Producing *Escherichia coli* (STEC)

- **Annual illness (death): 176,152 (20)**
- **Notable outbreak:** 1992-1993 outbreak in pacific northwest- Very important regulatory status (adulterant)
- **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-spore forming		
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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Shiga Toxin-Producing *Escherichia coli* (STEC)

- **Animals that can spread *E. coli* O157 to humans include**:
  - -Cattle, especially calves (As high 80% in some herds),
  - *[Concentrated and genetic similarity]*
  - -Goats
  - -Sheep
  - -Deer

- *E. coli* infection very common in **cats and puppies younger than one week**.
- **Colostrum**, plays a pivotal role in protecting a newborn the animal's undeveloped immune system against *E. coli* infection.
- As high as **80% of agricultural animals could carry various serogroups of shiga-toxigenic *E. coli*** without having symptoms

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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

Yersinia pestis 14th Century Outbreak in Europe, c. 30 to 50% of the population

Antoni van Leeuwenhoek: Discovery of bacteria in 1676 (c. 350 years)

Viruses discovered in 1890s

- *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-spore former, 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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Foodborne Streptococcus spp.

- *Not a reportable disease, no statistics available (not part of active surveillance data of CDC)*
- **Infection causes** sore throat, tonsillitis and fever
- **Primary sources**: **Infected sites of humans and animals**, **raw milk**
- **Contributing factors**: Infected **workers handling food** and **consumption of raw milk** or **meat products**.
- **Symptoms**: meningitis, sepsis, and pneumonia (>270,000 sepsis cases per year, not foodborne)
- **Found in**: cattle, horses, dogs, rabbits, guinea pigs and mice
- Important cause of mastitis in cows.

Growth parameters	Minimum	Optimum	Maximum
Temperature	50°F (10°C)	99°F (37°C)	<113°F (<45°C)
pH	4.8-5.3	7	>9.3
%NaCl (salt)	-	-	<6.5
Other	Non-sporeformer		
Atmosphere	Facultative - grows with or without oxygen		

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

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Shigella spp.

- **Infection in humans causes** diarrhea, which may be watery to bloody. The infection is also known as dysentery [Taxonomy similar to *Salmonella* serovars]
- **Primary sources**: Human and Animal intestinal tract
- **Transmitted** by **fecal contamination** from contaminated **water** or **infected food**.
- **Clinical signs are rare in dogs and cats**, mostly mild diarrhea.
- Many species such dogs, cats, rodents and nonhuman primates could **carry the pathogen asymptomatically.**

Growth parameters	Minimum	Optimum	Maximum
Temperature	43°F (**6.1°C**)	-	117°F (47.1°C)
pH	4.8	-	9.3
a_W	0.96	-	-
Other	Non-spore former		
Atmosphere	Facultative - grows with or without oxygen		

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

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Mycobacterium bovis

- **Infection** causing respiratory symptoms and **tuberculosis**
- **Primary sources**: Cattle and raw milk
- **Other source**: bison, elk, and deer.
- **Contributing factors**: Lack of milk **pasteurization** and exposure to aerosols from infected animals
- **Grows very slowly and under reduced oxygen (microaerophilic)**
- The **US has nearly eliminated** *M. bovis* infection from cattle, over **one million animal is tested** for the bacterium by inspectors. [USDA FSIS]
- *M. bovis* can be found in **wild animals** such as bison, elk, and deer; uninfected cattle that come into contact with these wild animals can become infected.

Source: CDC at https://www.cdc.gov/tb/publications/factsheets/general/mbovis.pdf

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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 (2006-07), 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**

One of the student from class published a great article about this pathogen:
https://www.mdpi.com/2076-2607/7/3/77

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

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Exercise 3

- What is DALY and how bacterial, parasitic, and viral foodborne diseases are ranked based on this public health index?
- What are the leading causative agents for foodborne illness in the United States?
- What are the leading causative agents for foodborne hospitalization in the United States?
- What are the leading causative agents for foodborne death in the United States?
- What food categories are responsible for vast majority of foodborne illness and death in the United States?
- Please name two foodborne bacterium that could grow at refrigeration temperature?
- Please name a foodborne bacterium that is capable of forming spores.
- Which bacterium was halophilic and predominantly exist in seafood? What is the definition of halophilic?
- What are the symptoms of *Cronobacter sakazakii* infection in infants and what are the prevention strategies?
- Among the foodborne infectious diseases we discussed today, which one you considered as the most important from a public health perspective? Please explain briefly.

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Additional Resources

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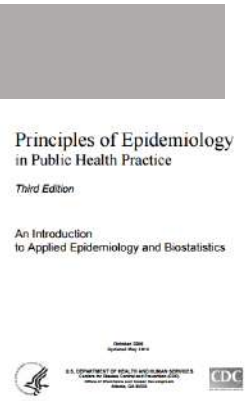
Additional Resources:

Centers for Disease Control and Prevention:
https://stacks.cdc.gov/view/cdc/6914

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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Dr. Aliyar Cyrus Fouladkhah
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afouladk@tnstate.edu|
Phone: (970) 690-7392

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Assignment and Recommendations

https://publichealthmicrobiology.education/

SCOPE OF WORK

Assignment Title: 2024 Food Safety and Public Health Certified Workshop
Assignment Number: GEO-2083-013
Assignment Location: Georgia Region/State: Tbilisi and Samegrelo-Zemo Svaneti Region
F2F Country Project: Food Safety
Date Range & Length: April 2024
Assignment PERSUAP Type: Type 3: Volunteers are not expected to be involved in pesticide issues at all.
Assignment Topics: Other

Project Overview

The John Ogonowski and Doug Bereuter Farmer-to-Farmer Program provides technical assistance from U.S. volunteers to farmers, farm groups, agribusinesses, and other agriculture sector institutions in developing and transitional countries with the goal of promoting sustainable improvements in food security and agricultural processing, production, and marketing. The program leverages the expertise of volunteers from U.S. farms, universities, cooperatives, private agribusinesses, and nonprofit farm organizations to respond to the local needs of host-country farmers and organizations.

ACDI/VOCA's Farmer-to-Farmer program drives sustainable, broad-based economic growth and strengthens agricultural sector institutions in Armenia, Georgia, and Kyrgyzstan. The five-year program is funded by the United States Agency for International Development (USAID).

Summary of Assignment

FSPCA Preventive Controls for Human Food is a course offered all over the world and in the United States, and its curriculum is recognized as adequate by the U.S. Food and Drug Administration. This course details food safety and preventive measures, and those who complete it become Preventive Control Qualified Individuals and receive a certificate from the Food Safety Preventive Controls Alliance. Usually, this course is around 800-850 euros, but as a gesture of goodwill from Lead Instructor Dr. Aliyar Cyrus Fouladkhah of the Public Health Microbiology Foundation, he is willing to facilitate covering all the costs of up to 10 participants to attend this course. 3-4 days of an intensive workshop will be conducted, and participants will receive their certifications on the last day of the workshop. The following is the tentative list of participants expressing interest in participating in this certification workshop, which comprises of individuals from different public or private food safety agencies and audit companies. After completion of the workshop, the selected audience will become Preventive Control Qualified professionals and will be able to apply their knowledge of the newest standards and practices in Food Safety.

1. Tamar Nozadze - Founder and Chief Executive Officer (CEO) at Food Safety Consulting Group
2. Dali Medoidze - Inspector of the Tbilisi Division of the National Food Agency. (Master of Health Sciences).
3. Tornike Atabegashvili - farmer, entrepreneur, veterinarian and trainer
4. Tornike Lashkarashvili - works in Nutrimax on the formulation of animal feed formulas, trainer, PhD.
5. Andria Kalandia - works at Nutrimax and is also a consultant, MS degree
6. Mikheil Buzariashvili-Lead Auditor for Food safety AQS consulting;
7. Lana Chvamania-Farmer to Farmer Program Coordinator

8. Magda Menabde-Farmer to Farmer Country Director

Detailed curriculum is currently under development by Dr. Aliyar.

Volunteer Profile & Qualifications

Lead Instructor Dr. Aliyar Cyrus Fouladkhah from Public Health Microbiology Foundation, Nashville, TN is requested for this assignment as an authorized trainer to conduct certified workshop.

Assignment Tasks

Prior to departure, the Volunteer should be in contact with the field office, provide all the necessary materials for the assignment, and coordinate with the Country Director and Program Coordinator on the detailed agenda and curriculum for the workshop.

While in-country, the Volunteer will:

- Conduct a 3-4-day intensive workshop held in F2F program Tbilisi office.
- Travel to Zugdidi for a 3-4-day follow-up assignment to meet with Agrouhouse (former F2F host) and train laboratory staff on food safety issues and making tests.

Upon completion of the assignment, the Volunteer will:

- Submit a **Final Report** using the template provided as part of the Welcome Packet
- Conduct at **least two outreach activities** to share your experience with your community. Such outreach activities can include hosting talks with professional, religious, or community groups, and contacting the media.

The Volunteer should mention that the Farmer-to-Farmer Program is funded by USAID and communicate all outreach efforts and events to F2FVolunteer@acdivoca.org.

OPTIONAL*

If possible, the Volunteer will reach out to their professional network and suppliers to see if any tools can be gathered for donation to the host. The desired items are:

- Click or tap here to enter text.
- Click or tap here to enter text.
- Click or tap here to enter text.

* Please note that ACDI/VOCA headquarters must approve **all** assignment-related expenses **prior** to the volunteer's departure

Deliverables

- Training of Trainers workshop and certification
- The selected audience will become Preventive Control Qualified professionals and will be able to apply their knowledge of the newest standards and practices in Food Safety
- **FINAL REPORT** including a list of recommendations to be adopted by the host organization, to be submitted on the last day of the assignment (template included in the Welcome Packet).

- **VOLUNTEER CERTIFICATION FORM** filled out and submitted on the last day of the assignment
- **VOLUNTEER EXPENSE REPORT** submitted electronically within 30 days of returning to the U.S.
- **PARTICIPATION IN BI-ANNUAL SURVEY** sent by ACDI/VOCA to measure outreach and advocacy

Expected Results/Impact

Beneficiaries: Female-7; Male-4
Other Results/Impact: The volunteer's report will identify key findings critical to success of the enterprise

Host Organization

Type of Host Organization: F - Individual Private Farmers
Type of Volunteer Assistance: T – Technology Transfer
Value Chain Activity: F – On Farm Production

Name: Food Safety Consulting Group

Tamar Nozadze, Ph.D.
Invited Lecturer at Georgian Technical University
Young Scientist at Academy of Agricultural Sciences of Georgia
Founder and Chief Executive Officer (CEO) at Food Safety Consulting Group
T. +995 555 29 28 97; +995 595 07 56 24
E-mail: tamar.nozadze27@gmail.com food.safety.consulting.group@gmail.com
Can the Volunteer get in contact with the host organization before the assignment? ☒ Yes ☐ No
If yes, what is the best way for the Volunteer to get in contact with the host organization?
tamar.nozadze27@gmail.com

Organization Profile

This group comprises of individuals from the different public or private food safety agencies and audit companies. After completion of the workshop, the selected audience will become Preventive Control Qualified professionals and will be able to apply their knowledge of the newest standards and practices in Food Safety and will be able to work individually in their private or government companies to consult, audit and monitor Food Safety-related projects all over Georgia. This participant list may alter depending on timing of the assignment and availability of each individual after volunteer confirms availability.

1. Tamar Nozadze - Founder and Chief Executive Officer (CEO) at Food Safety Consulting Group
2. Dali Medoidze - Inspector of the Tbilisi Division of the National Food Agency. (Master of Health Sciences).
3. Tornike Atabegashvili - farmer, entrepreneur, veterinarian and trainer
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7. Lana Chvamania-Farmer to Farmer Program Coordinator
8. Magda Menabde-Farmer to Farmer Country Director

Has the organization hosted previous Farmer-to-Farmer assignments? ☐ Yes ☒ No

There are two hosts to this assignment. 1st is group comprised of individuals not related to each other and second host is Maia Mikava, who has hosted similar assignment with Dr. Aliyar.

Organization Justification

ACDI/VOCA's goal for the Food Safety Country Project in Georgia is to foster sustainable and inclusive economic growth through technical volunteer assignments that help value chain actors improve market access and outcomes through improved food safety practices. Certified workshop gives opportunity to selected audience to upgrade their knowledge of FS practices and become Preventive Control Qualified professionals and apply their knowledge when working with small and medium size enterprises to produce safer and high-quality food products.

Logistics & Itinerary

Day 1	Briefing with ACDI/VOCA F2F staff; preparation for the workshop
Day 2	Full day workshop (agenda to be developed by trainer)
Day 3	Full day workshop (agenda to be developed by trainer)
Day 4	Full day workshop (agenda to be developed by trainer)
Day 5	Full day workshop /Certificate award ceremony
Day 6	Travel to Zugdidi
Day 7	Work in the field on assignment-related issues
Day 8	Work in the field on assignment-related issues
Day 9	Work in the field on assignment-related issues
Day 10	Work in the field on assignment-related issues/ Back to Tbilisi
Day 11	Work on final report and assignment related documents in ACDI/VOCA F2F office
Day 12	Departure to U.S.

For information on this project as well as other ACDI/VOCA projects in the country and region please refer to our website, www.acdivoca.org. For general information about the worldwide Farmer-to-Farmer program, please refer to www.farmer-to-farmer.org.

Attached, please find the Country Profile for the country of assignment.