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# Climate Change, Infectious Diseases, and Microbial Food Safety Short Course in Port-au-Prince, Haiti



Trip Report (June 2022)

USAID Assignment on March 2022, Port-au-Prince, Haiti



*Dr. Aliyar Cyrus Fouladkhah, PhD, MPH, CFS, CPH  
Founding Director, Public Health Microbiology Foundation™  
Associate Professor, Tennessee State University  
Yale School of Public Health Alumnus*



It was a great pleasure for me to travel to Port-au-Prince for another USAID assignment in beautiful and culturally-rich country of Haiti. During the visit, I held a public health and food safety workshop that in addition to members of local USAID offices, RANFOSE, and members from the food industry, had participants from the senior members of Haiti Government. During the workshop we discussed important topics about transboundary infectious diseases, microbial food safety for human food manufacturing, and held important talks and discussions about climate change effects on food security and food safety. The current report contains excerpts of the information discussed with the participants.

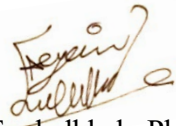
In addition to USAID and farmers-to-farmers program, the event was partially funded by the Public Health Microbiology Foundation<sup>TM</sup> in Nashville, TN and provided certifications and books to 17 Haitian individuals. A very similar certification program using the same curriculum is scheduled in Alexandria, VA USA (scheduled for September 12, 2022), costing the attendees \$895 per person. Thus, conservatively estimating, the current sponsorship value from the foundation is  $(17*850=)$  \$14,450. Additionally, participants receive food safety textbook/participation manual, costing collectively  $(17*\$40=)$  \$680.

For the 17 participants of the workshop, I specifically recommend:

- (1) Incorporating food safety plan and risk assessment discussed in the meeting as part of food manufacturing practices (recommendation for members of food industry participants).
- (2) Including the discussed transboundary infectious diseases as part of importation of food products and for tourism by the country's ministry of health (recommendation for members of the ministry of health participated in the workshop).
- (3) Incorporating information about climate change on food security and public health for justifying the need for further fortification programs based on information provided in the workshop (recommendation for members of RANFOSE participated in the workshop).

In addition to sponsorship from the Public Health Microbiology Foundation™ (\$15,130), I would like to thank USAID offices in Washington and Port-au-Prince for all they have done for harmonizing the events of this program. Special recognition is also needed for Dr. Ruth Climat from RANFOSE who additionally supported the event of this productive and impactful assignment in Haiti.

Best wishes,

A handwritten signature in brown ink, appearing to read 'Fouladkhah' with a flourish at the end.

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

Founding Director, Public Health Microbiology Foundation™

Faculty Director, Public Health Microbiology Laboratory

Associate Professor, Tennessee State University

Yale School of Public Health Alumnus

# Workshop Invitation



**Additional Information about the Public Health Microbiology Foundation Could be Accessed at:**

**<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  
Webpage: <https://publichealthmicrobiology.education/>

**Public Health & FSMA Preventive Control for Qualified Individual (PC QI) Workshop**  
**March 21 to 24 2022, Lead Instructor: Dr. Aliyar Cyrus Fouladkhah\* March 17, 2022**

Dear participants,

It is my pleasure to welcome you to our 2022 food safety and public health workshop. During this multiday event, in addition to information from the public health microbiology Foundation in Nashville, I will cover the FSPCA curriculum, currently recognized as adequate by the Food and Drug Administration in the United States for Food Safety Modernization Act (FSMA) Preventive Control for Qualified Individuals (PC QI) training. This workshop will be held in person for the industry, academia, government, and NGO members in Port-au-Prince, Haiti in collaboration with USAID Partners of America. Due to ongoing national and global respiratory pandemic/endemic participants are 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 March 22 to 24 2022, during the below-mentioned times. We will additionally hold optional meetings on March 25, 2022 for further specific and one-by-one discussions/consultation about food safety and public health practices for each entrepreneur or participants. 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 improving the safety of your operation and 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,

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 Public Health Microbiology Foundation is gratefully acknowledged.*



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Webpage: <https://publichealthmicrobiology.education/>

**Workshop Schedule:**

**Tuesday, March 22, 2022** (required): 9:00 am to 5:00 pm

- ✚ Introductions from instructor and participants
- ✚ FSMA Overview\*
- ✚ Food Safety Under the Landscape of Climate Change\*
- ✚ Chapters 1 to 7^

**Wednesday, March 23, 2022** (required): 9:00 am to 5:00 pm

- ✚ Exotic and Transboundary Diseases\*
- ✚ Chapters 8 to 12^

**Thursday, March 24, 2022** (required): 9:00 am to 5:00 pm

- ✚ Labeling and Claims and GRAS List\*
- ✚ Chapters 13 to 16^s
- ✚ Watching 2 vidoes: Regulation Overview and FSMA Technical Assistance
- ✚ Awarding of the certificates

**Friday, March 25, 2022** (Optional): 9:00 am to 5:00 pm

- ✚ One-on-one consultation with a process authority
- ✚ Individual discussions about product safety and regulatory affairs

\* *From the public health microbiology foundation, ^from the FSPCA curriculum*

**For completion of workshop evaluation survey, you could use the below weblink or Scan this QR code with your cellphone:**

**[https://tnstateu.az1.qualtrics.com/jfe/form/SV\\_1Xn2KKL0IK4w05M](https://tnstateu.az1.qualtrics.com/jfe/form/SV_1Xn2KKL0IK4w05M)**



# The Certificates



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**<https://publichealthmicrobiology.education/>**



FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

# CERTIFICATE OF TRAINING

is awarded to

**Dr. Haim Joseph Corvil**

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

03/23/2022

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Jason Wan, Interim Director  
Institute for Food Safety and Health

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Gerald Wojtala, Executive Director  
International Food Protection Training Institute

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Steve Mandernach, Executive Director  
Association of Food and Drug Officials



Certificate # 63cb9783







FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 8d5c955a





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 81ab6ab4





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 6321d02b





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Certificate # 90f2b96f





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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**Huygens Salomon Bijou**

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Certificate # 430ec615





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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**Marc-Donald Simeus**

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Certificate # 37f0e414





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 6bedaeca





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Certificate # 3d595b0c







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Certificate # 55e956c0





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Certificate # 2b8ceef8





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Certificate # 3595b70f





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Rose Michèle Saint Jean Zephirin

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Certificate # 33f7fe5d





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Certificate # 2b5f5e97





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 0f51b4e3





FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

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Certificate # 2c98fb75





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Certificate # 62099d64





# Workshop Evaluation



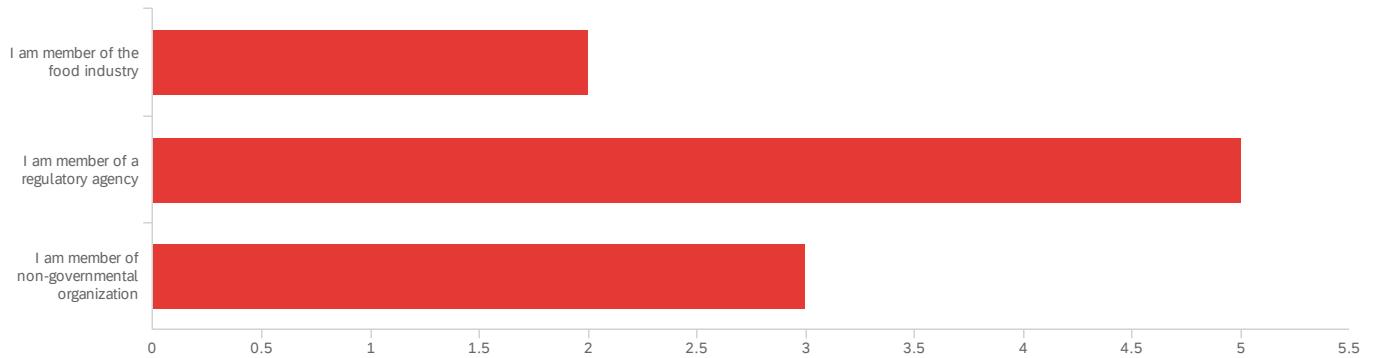
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**<https://publichealthmicrobiology.education/>**

# Default Report

2022 FSMA PC QI Workshop (3-21 to 23-2022): Lead Instructor: Dr. Aliyar Cyrus Fouladkhah - Copy - Co  
June 8, 2022 3:35 PM MDT

## Q1 - What is your primary career association?

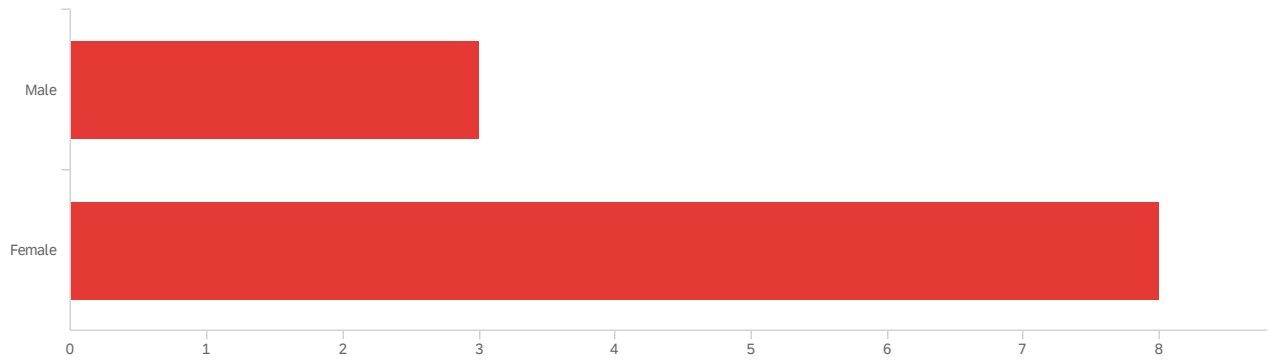


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What is your primary career association?	1.00	3.00	2.10	0.70	0.49	10

#	Field	Choice Count
1	I am member of the food industry	20.00% 2
2	I am member of a regulatory agency	50.00% 5
3	I am member of non-governmental organization	30.00% 3
		10

Showing rows 1 - 4 of 4

## Q2 - What is your gender?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What is your gender?	1.00	2.00	1.73	0.45	0.20	11

#	Field	Choice Count
1	Male	27.27% 3
2	Female	72.73% 8

11

Showing rows 1 - 3 of 3

Q3 - How satisfied are you for attending this workshop: 0=Not satisfied at all;

100=extremely satisfied

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	My instructor is knowledgeable of the subject matter.	75.00	100.00	92.82	9.57	91.60	11
2	My instructor communicated effectively.	70.00	100.00	91.18	10.18	103.60	11
3	My instructor stimulated my interest in the subject.	69.00	100.00	88.18	13.48	181.60	11
4	My instructor answered questions thoroughly.	70.00	100.00	91.00	11.13	123.82	11
5	My instructor treated all students with respect.	81.00	100.00	96.10	7.12	50.69	10
6	I would recommend this instructor to my friends.	74.00	100.00	90.73	10.27	105.47	11
7	My knowledge of the subject increased as a result of this workshop.	69.00	100.00	85.82	10.87	118.15	11
8	This workshop made a significant contribution to my career.	80.00	100.00	93.55	8.40	70.61	11

Q4 - Please share any information or feedback you would like with the instructor about your experience in this workshop:

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

---

Je vous remercie énormément pour votre méthode de travail, votre gentillesse, vos partages de connaissance. Cet atelier m'est très bénéfique. Et les connaissances apprises lors de cet atelier vont être appliquées à mon travail. Encore une fois, merci!

Thanks so much for amazing course and great discussions

It would be do the training in 3 days to cover the 16 chapters.

**End of Report**

# Excerpts of Teaching Material



**Additional Information about the Public Health Microbiology Foundation Could be Accessed at:**

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## Food Labeling and Packaging Claims FDA's Generally Recognized as Safety List

**3-23-2022**  
**Tennessee State University, Nashville, TN**  
**A. Fouladkhah: Faculty Director, Public Health Microbiology Laboratory**



1

### Food Labeling and Advertising

**Food Labeling:**

- Valuable source of information for consumers
- Could be false, misleading, or true-but-trivial marketing claims

*e.g.* Cholesterols-free potato chips; No Added sugar (added juice); Made with real fruit; N&A flavors; WONF vanilla extract

- Challenge for consumers:**
  - Distinguish the signal from noise
- Challenge for policy makers:**
  - Strengthening the signal to noise ration



2



### Food Labeling and Advertising

**Regulation for food producers:**

- Mandatory information
- Voluntary information: weakly regulated
- Voluntary information: strongly regulated
- Prohibited Claims

**Consumers can get information:**

- Search properties:** comparing products in market
- Experience properties:** relying on personal experience
- Credence properties:** consumers cannot confirm product quality

*e.g.:* organic production; country of origin; nutrition and health claims; humane treatment of workers or animals (fair trade)

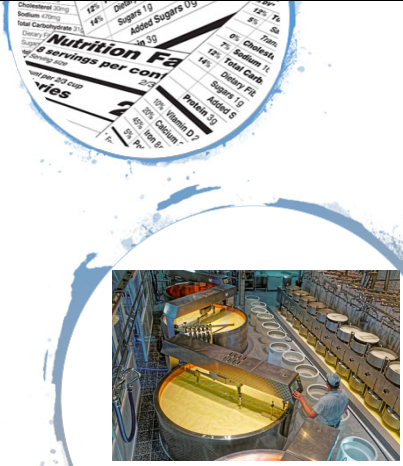
3

### Food Labeling and Advertising

- The food industry is one of the United States' largest manufacturing sector
- 10 percent of all shipments in the United States are associated food industry
- More than a third of the world's top 50 food and beverage processing firms are headquartered in the United States (CASE, 2021)
- Efficiency and public health?

**FDA's Four Flavor Categories**

- Natural Flavors
- Natural With Other Natural Flavors (WONF)
- Artificial Flavors
- Natural and Artificial (N&A) Flavors



4

## Claims About Nutrition and Health

- Four Types of Claims are Possible for Food Products:
  - (1) Nutrient Content Claim
  - (2) Health Claim
  - (3) Qualified Health Claims
  - (4) Structure/Function Claims
- **All must be in close harmony with Dietary Guidelines for Americans**
- **Must be evaluated by regulatory agencies**



5

## Claims About Nutrition and Health

### (1) Nutrient Content Claim:

Describes level of nutrient or food component  
e.g. "Low sodium," "Low fat," "High in oat bran."

Must follow **specific requirements of NLEA**

**The Nutrition Labeling and Education Act of 1990 (NLEA)**

#### Sodium as an example:

- < 5 mg per reference amount\*: "**Sodium Free**"
- Reduced by at least 25% from reference amount "**Reduced Sodium**"
- Reduced by at least 50% from reference amount "**Light in Sodium**"
- 140 mg or less per reference amount "**Low Sodium**"

*Reference amount should be obtained from: Reference Amount Customarily Consumed (RACC)*



6

## Claims about Nutrition and Health

### (1) Nutrient Content Claim:

- **True-but-misleading claims** must be prohibited e.g. "low-fat broccoli!"
- **Half-truth** and misleading claims must be prohibited e.g. if the product: **Both high in saturated fat and high in fiber, the claim:**

**Claim could not just mention "High in fiber"**

**Reason:** Against the Dietary guideline: Food high in Saturated fat could not be promoted



7

## Claims about Nutrition and Health



### Authorized Health Claims That Meet the Significant Scientific Agreement (SSA) Standard

### (2) Health Claim (aka Real or Authorized Health Claim)

- **Connects a food product to disease or health condition**
- e.g. "may reduce the risk of heart diseases"
- Another example: Adequate calcium and vitamin D as part of a healthful diet, along with physical activity, **may reduce the risk of osteoporosis later in life.**
- This requires approval from **Food and Drug Administration**
- Only approved if there is "**significant scientific agreement**"
- **Has to be derived from a statement from Dietary Guideline or highly respected authorities/institutions (IOM)**
- Usually, a **lengthy process and rare in food industry** *[Out and Cholesterol]*
- **[Cost for clinical trials >\$40K per patient, >\$19m for a new drug or health claim]**

#### Approved Health Claims

- Calcium, Vitamin D, and Osteoporosis
  - 21 CFR 101.79 Health Claims: calcium and osteoporosis
  - Final Rule: Food Labeling: Health Claims: Calcium and Osteoporosis, and Calcium, Vitamin D, and Osteoporosis September 2008
- Dietary Lipids (Fat) and Cancer
  - 21 CFR 101.72 Health Claims: dietary lipids and cancer
- Dietary Saturated Fat and Cholesterol and Risk of Coronary Heart Disease
  - 21 CFR 101.78 Health Claims: dietary saturated fat and cholesterol and risk of coronary heart disease
  - Final Rule: Food Labeling: Health Claims: Dietary Saturated Fat and Cholesterol, and Risk of Coronary Heart Disease December 2009
- Dietary Non-carbohydrate Carbohydrate Sweeteners and Dental Caries
  - 21 CFR 101.86 Health Claims: dietary non-carbohydrate carbohydrate sweeteners and dental caries
  - Final Rule: Food Labeling: Health Claims: Dietary Non-carbohydrate Carbohydrate Sweeteners and Dental Caries May 2008
- Fiber-Rich Foods: Health Claims: Dietary Fiber, Soluble Fiber, and Heart Disease
  - Final Rule: Food Labeling: Health Claims: Dietary Fiber, Soluble Fiber, and Heart Disease July 1993
  - Final Rule: Food Labeling: Health Claims: Dietary Fiber, Soluble Fiber, and Heart Disease December 1992
  - Final Rule: Food Labeling: Health Claims: Dietary Fiber, Soluble Fiber, and Heart Disease August 1995
- Fiber-containing Grain Products, Fruits and Vegetables and Cancer
  - 21 CFR 101.76 Health Claims: fiber-containing grain products, fruits, and vegetables and cancer

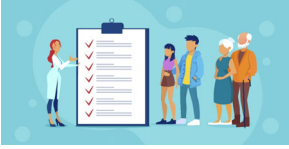
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## Claims about Nutrition and Health

### (3) Qualified Health Claim

- Is a claim that **lack significant scientific agreement**
- **FDA allows such claim when some health benefit studies are available.**
- **Label should indicate:**
- “*FDA has determined that this evidence is limited and not conclusive*”
- They should also indicate “*This statement is not approved by FDA.*”



- “Scientific evidence suggests, but does not prove, that whole grains (three servings or 48 grams per day), as part of a low saturated fat, low cholesterol diet, **may reduce the risk of diabetes mellitus type 2.**”

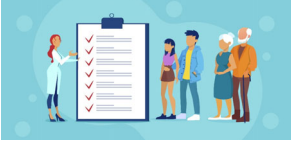
- Could lead to **legal complication** for companies if not stated correctly.

9

## Claims about Nutrition and Health

### (4) Structure and Function Claim

- **Connects food to structure or function of human body**
- **Most common in the food industry**
- Allows food industry to “**hint**” at **health benefits**
- Does **not** require FDA approval
- But companies would **need to have strong scientific evidence [DGA or IOM]**





“**Prevents Osteoporosis**” is a **health claim** requires lengthily FDA approval

“**Builds strong bones**” is a **structure/function claim** that does **not** require FDA approval

10

## FDA GRAS LIST

- Any substance that is **intentionally added to food** is a **food additive**
- **All additives** are: subject to **premarket review and approval by FDA, unless those with GRAS status**
- Food Industry is **extremely dynamic** with many ingredients (**natural and artificial**)
- **Practically impossible** for companies to test all ingredients for safety
- There is a similar list (**Animal Food GRAS**) for feed industry
- **When an ingredient is not listed in GRAS list:**
- Manufacturer may obtain GRAS status by **applying to the FDA**
- This is much **less conservative than pharmaceutical industry.** [LD50 in animals/100]
- Takes over **10 years** to receive approval for new drugs [typically >\$19 B]

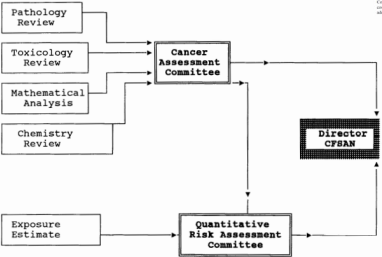

  


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## Pre-market safety evaluation process

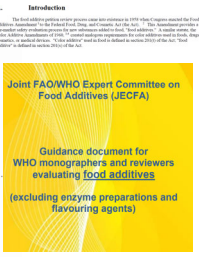
- **1958:** Congress enacted the **Food Additives Amendment to the Federal Food, Drug, and Cosmetic Act**
- **1960:** Color Additive Amendments to the **Federal Food, Drug, and Cosmetic Act**

Flow Chart Depicting the Various Groups Involved in the Assessment of Cancer Risk at the Center for Food Safety and Applied Nutrition (CFSAN) of the Food and Drug Administration



Chapter II  
Agency Review of Toxicologic Information in Petition for Direct Food Additives and Color Additives Used in Food


A. Introduction



12

## FDA GRAS LIST

- GRAS (Generally Recognized as Safe) list of FDA:
- **Help producers avoid unnecessary testing**
- Provide a list of all **approved ingredients** and **approval concentrations** [e.g. *nisin 900 IU/gram*]
- **Created in 1958** as amendment to Food and Drug Cosmetic Act
- Ingredients already in use **before 1958** received GRAS status **without testing (Old Additives)**
- **This created some problem:**
- Example: **1985 cinnamyl anthranilate** (artificial cinnamon flavor) linked to liver cancer.
- **Was part of GRAS list from 1958 to 1985**, banned in 1985.



**Generally Recognized as Safe (GRAS)**

“GRAS” is an acronym for the phrase Generally Recognized As Safe. Under sections 201(c) and 201(d) of the Federal Food, Drug, and Cosmetic Act (the Act), any substance that is intentionally added to food as a food additive, that is subject to premarket review and approval by FDA, whose use as a food additive is generally recognized, among qualified experts, as having been adequately shown to be safe under the conditions of its intended use, or whose use as the substance or otherwise exempted from the definition of a food additive.


Under section 201(c) and any of the Act, and FDA’s implementing regulations in 21 CFR 171.3 and 21 CFR 171.30, the use of a food substance may be GRAS either through scientific procedures or, for a substance used in food before 1958, through experience based on common use in food. Under 21 CFR 171.30(b), general recognition of safety through scientific procedures requires the same quantity and quality of scientific evidence as is required to obtain approval of the substance as a food additive. General recognition of safety through scientific procedures is based upon the application of generally available and accepted scientific data, information, or methods, which ordinarily are published, as well as the application of scientific principles, and may be corroborated by the application of unpublished scientific data, information, or methods.

Under 21 CFR 171.30(c) and 171.30(d), general recognition of safety through experience based on common use in food requires a substantial history of consumption for food use by a significant number of consumers.

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## FDA GRAS LIST


- A large online data inventory: **GRAS Notice Inventory**
- **Some decision controversial:**
- **Lysozyme**: an natural enzyme in human breastmilk
- In 2006, Artificially produced Lysozyme did not receive GRAS status for **infant formula**
- Other examples:
- **Caffeine** did not receive GRAS status for **caffeinated alcoholic beverages**
- **Trans fats** were part of GRAS list until 2015
- **Sodium chloride** is still on GRAS list, **IOM recommends removal**



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## FDA GRAS LIST

- **Major problems with GRAS list:**
- **Old additives** were not all reviewed
- Studies are not from **human clinical trials** (in vivo or animal studies) [*LDSO in animals divided by 100*]
- Do not consider the additives **synergism** [*Benzoic acid, sulfate, phosphoric acid, citric acid*]
- **Does not address color additives** (covered by FD&C act)
- **Does not address pesticides**
- **Does not address GMO**
- **Other agencies** have additional requirements:
- **USDA FSIS**: additives for meat products
- **Animal Food GRAS List**



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## FDA GRAS LIST

Food Additive

GRAS?

Yes, then apply exemption criteria

No, then apply additive approval criteria

**Food Additive Decision Tree for FDA Products**

Food Additive

FDA Approved?

GRAS

Food Additive Petition


FSIS Secondary Criteria Apply?

**Food Additive Decision Tree for FSIS Products**

Differentiating between **Food Additives** and **processing aids:**

**Antimicrobials** in meat industry

**Enzymes (lactase)** in dairy industry



Source: Institute of Food Technologists

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Thank you!

**Dr. Aliyar Cyrus Fouladkhah,**  
Faculty Director, Public Health Microbiology Laboratory, Tennessee State University  
[afouladk@tnstate.edu](mailto:afouladk@tnstate.edu)  
Phone: (970) 690-7392

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

CLIMATE REALITY LEADERSHIP CORPS

Public Health Microbiology Laboratory



## Global Climate Change in Picture

Public Health Microbiology Laboratory  
Tennessee State University, Nashville, TN  
A. Fouladkhah: Director, Public Health Microbiology Laboratory  
3-23-2022 Port-Au Prince

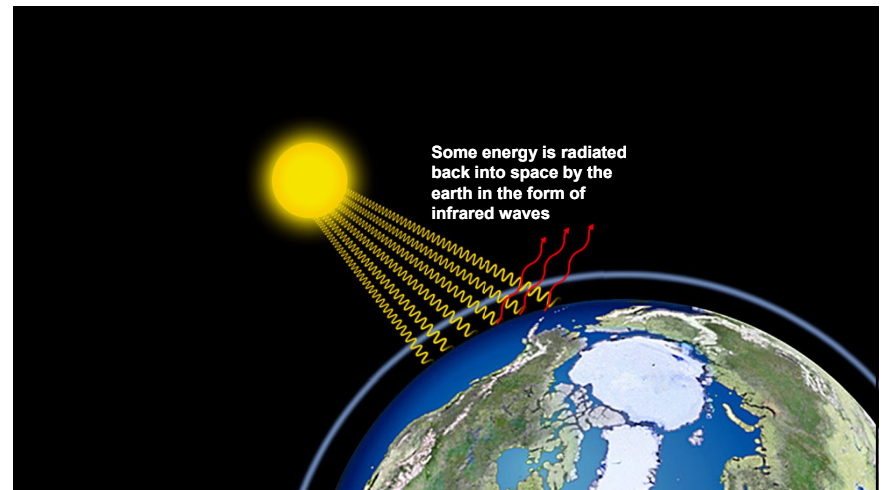
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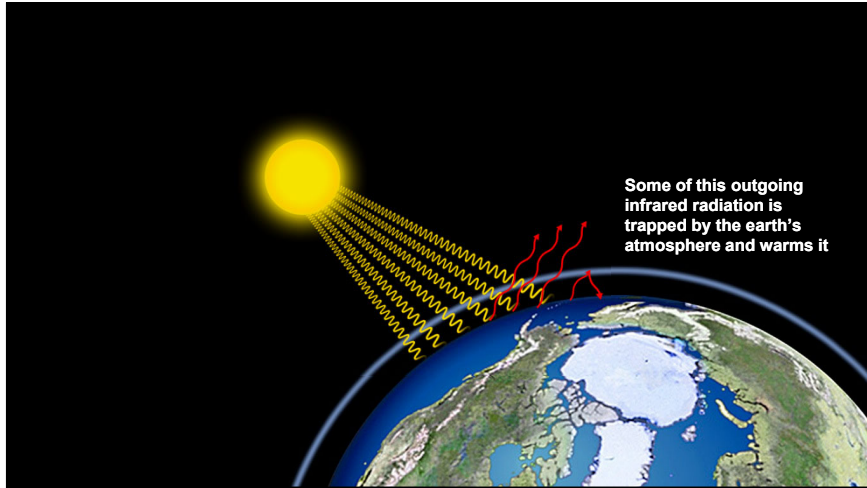
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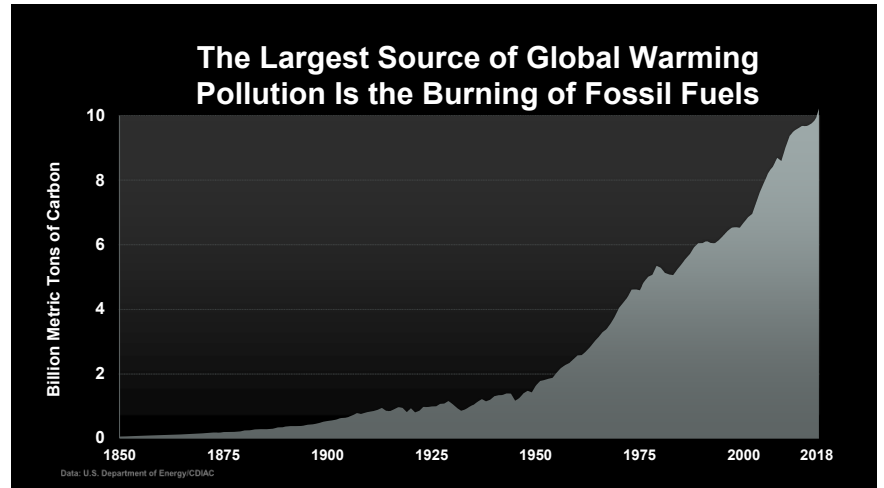
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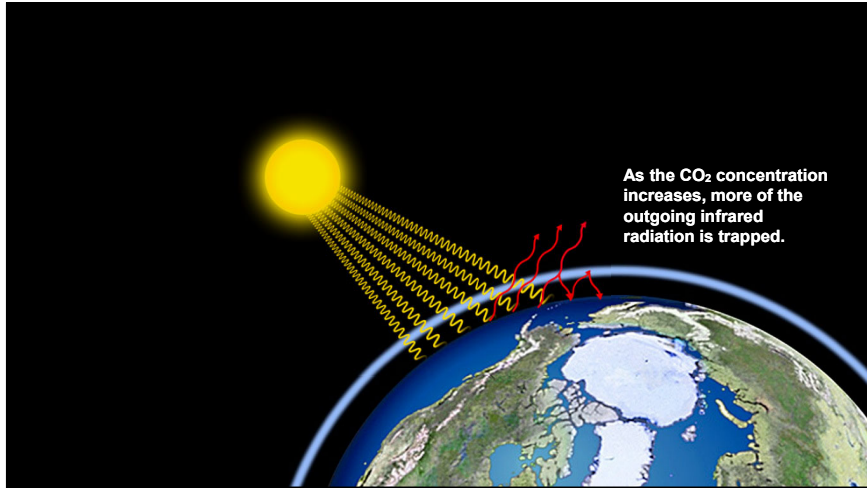
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The energy trapped by man-made global warming pollution is now “...equivalent to exploding

**600,000**

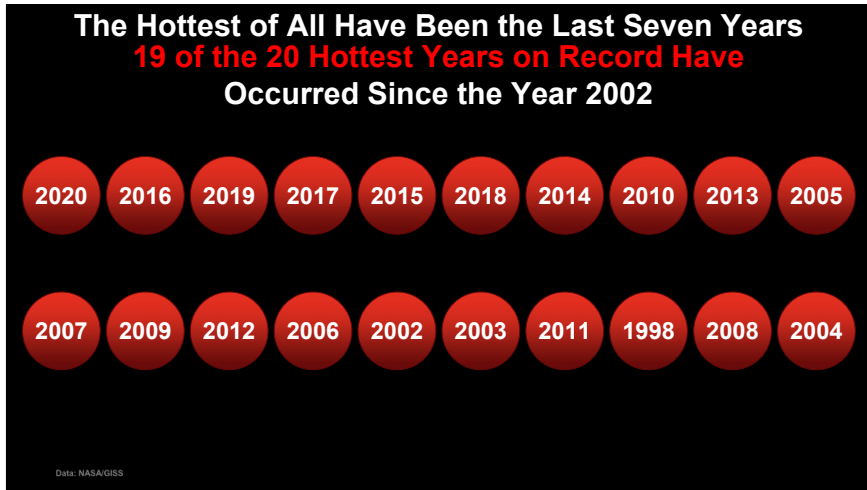
First-generation atomic bombs per day 365 days per year.”

James Hansen  
Former Director, NASA Goddard Institute for Space Studies

11



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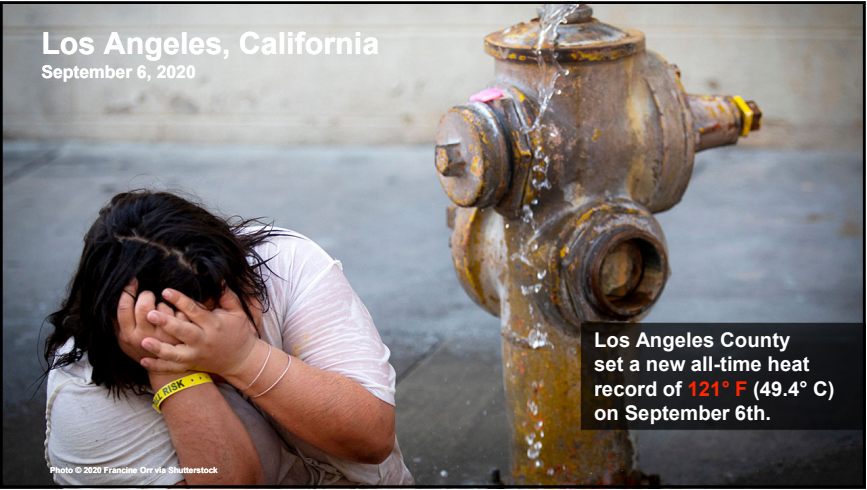
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**The U.S. Southeast is projected to warm up to 8 °F this century.**

14

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

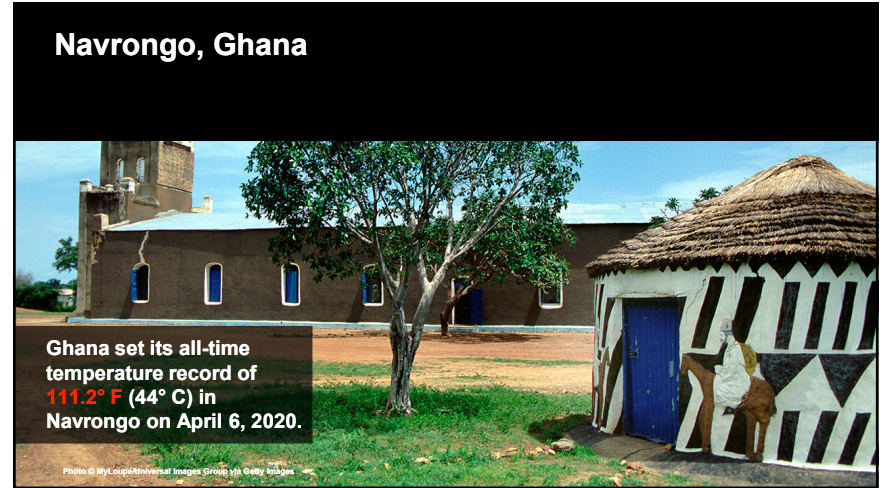
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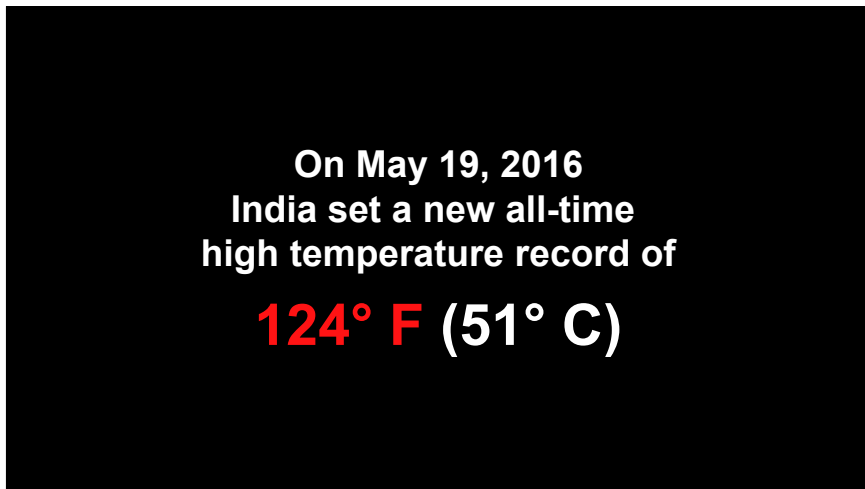




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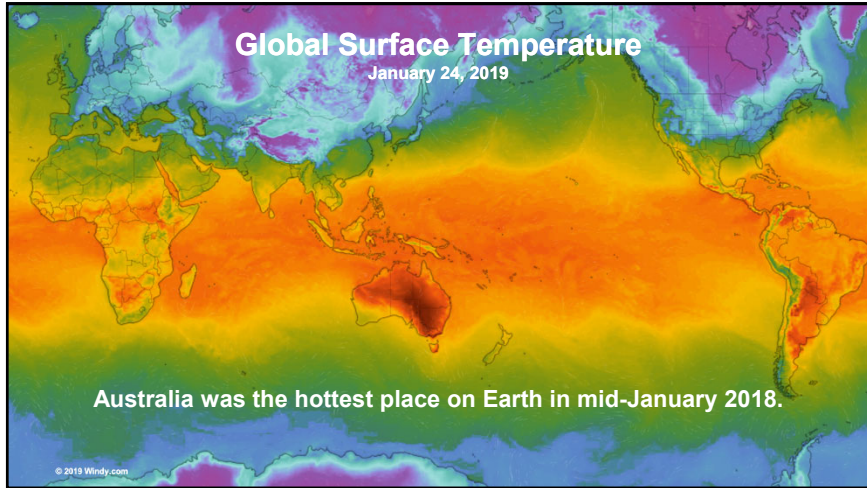
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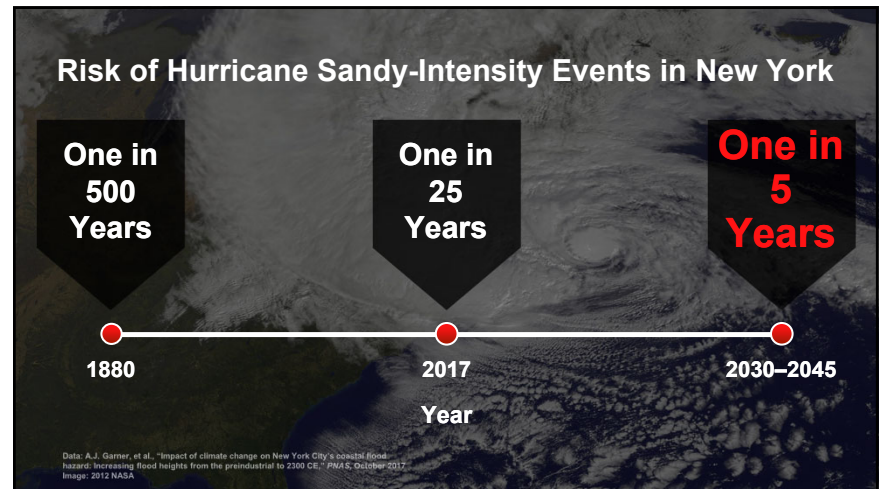


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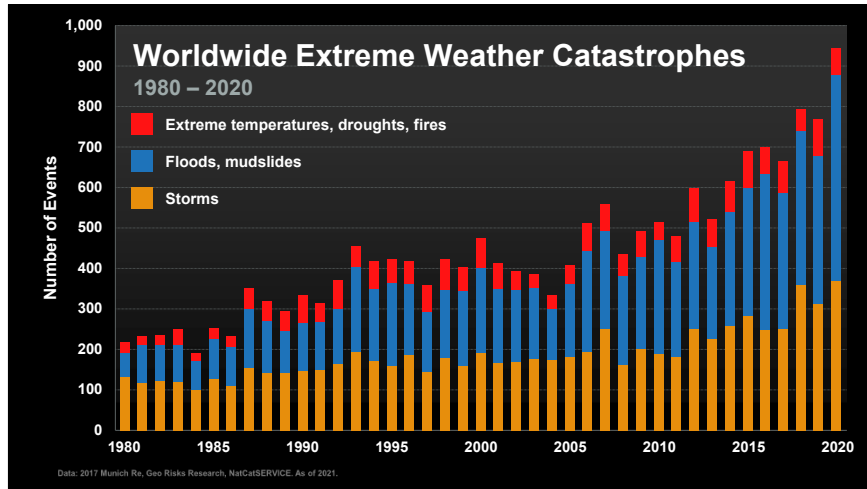
**“Unrestrained climate change means we will see many more Harveys in the future.”**

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

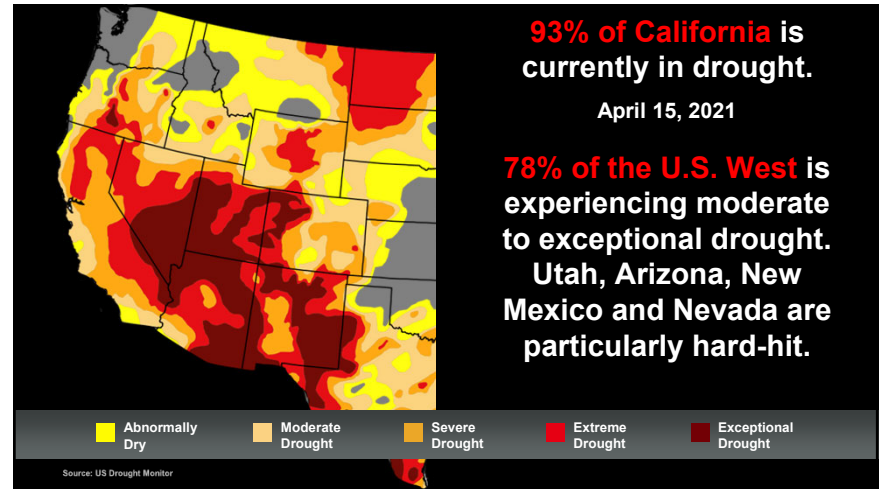
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**Paradise, California**  
November, 2018

The Camp fire killed 86 people and burned over 14,000 homes and businesses.

© 2018 Josh Edelson/AFP/Getty Images

45



**Durham, North Carolina**  
June 2018

© 2018 Jerry McRider/The Duraleigh Herald via AP

46



“I had 400 acres of wheat, and now it’s all desert.”

Ahmed Abdullah, Syrian farmer  
October 2010

© 2010 Julien Goldstein/The New York Times/Redux

47

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

48

“...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

49

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*



50

“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.”

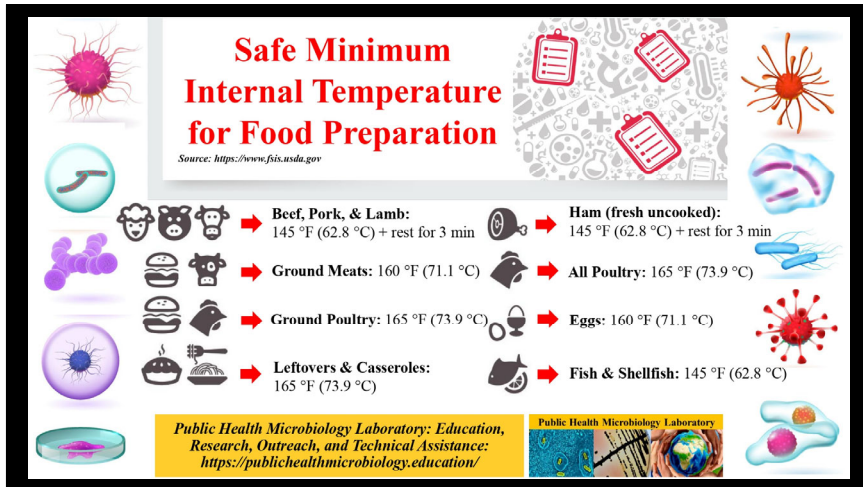
Jos Lelieveld  
The Max Planck Institute for Chemistry  
May 2016

51

The **heat index** in  
Bandar Mahshahr reached  
**165° F**  
(74° C) on July 31, 2015

52



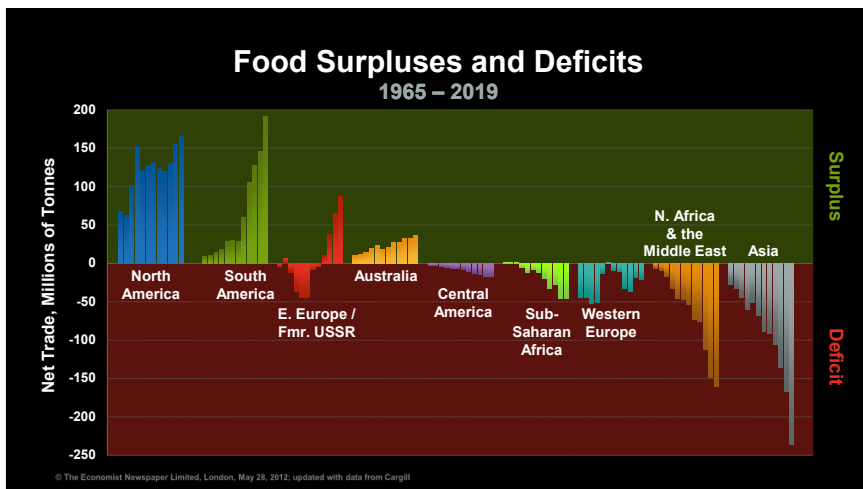


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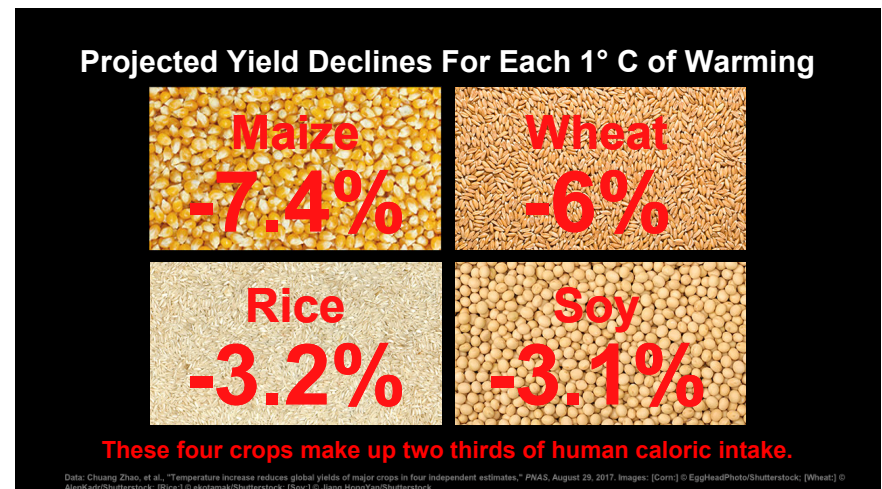
## The world could see over **1 billion climate migrants** by the end of this century.

The Lancet Countdown Report  
October 2017

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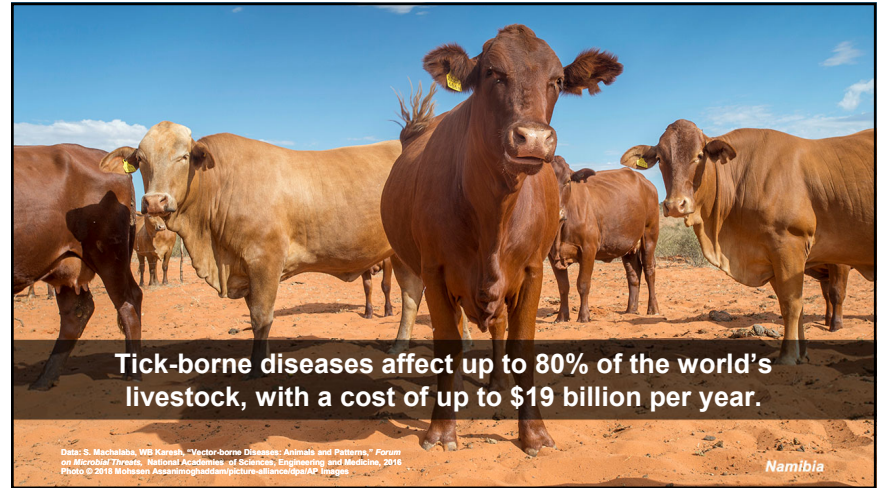


Climate change is projected to lower Georgia's **soy** yields up to **34%** and **corn** yields by as much as **46%** by 2050.

Photo © Christopher Beaswell via Shutterstock

Soybean Farm, Georgia

57



Tick-borne diseases affect up to 80% of the world's livestock, with a cost of up to \$19 billion per year.

Data: S. Machelaba, W.B. Karstad, "Vector-borne Diseases: Animals and Patterns," Forum on Microbial Threats, National Academies of Sciences, Engineering and Medicine, 2016  
Photo © 2018 iStockphoto.com/istockphoto/istockphoto

Namibia

58



### Sea turtle sex is determined by temperature.

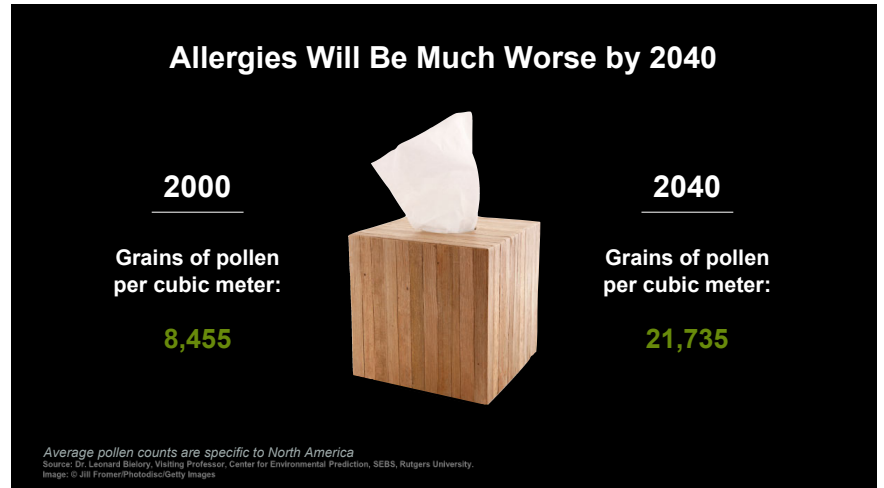
At the northern edge of Australia's Great Barrier Reef, **99% of young green sea turtles are now female.**

Since 1980, 85% of Jamaica coral reefs have been reduced  
Coral reefs 0.1% of Oceans, 25% of ocean lives

**Recently, great progress by "coral gardeners"**

Source: World Wildlife Fund, 2015  
Photo © 2005 iStockphoto.com/istockphoto/istockphoto

59




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

60

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

Most common blood pressure medication (ACE Inhibitor- Captopril) is originally isolated from a snake Venom...  
We only have access to non-extinct species.



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

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

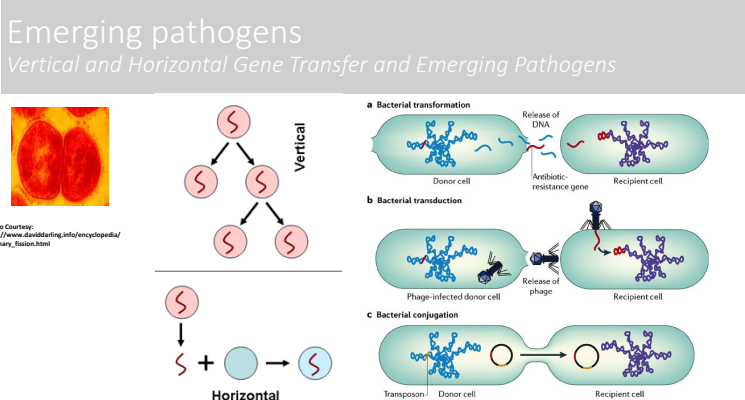
\* Calculated for oral ingestion based on epidemiological data from outbreaks and human feeding trials of volunteers. Data obtained from BBF of Food and Drug Administration (2<sup>nd</sup> edition).

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

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## Emerging pathogens

### Vertical and Horizontal Gene Transfer and Emerging Pathogens



**a Bacterial transformation**  
Donor cell → Release of DNA → Antibiotic-resistance gene → Recipient cell

**b Bacterial transduction**  
Phage-infected donor cell → Release of phage → Recipient cell

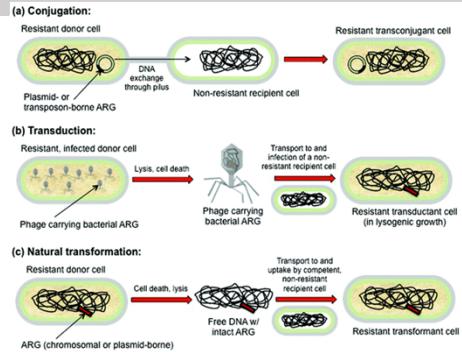
**c Bacterial conjugation**  
Transposon → Donor cell → Recipient cell

Photo Courtesy: [http://www.davidarling.info/encyclopedia/binary\\_fission.html](http://www.davidarling.info/encyclopedia/binary_fission.html)

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Nature Reviews | Microbiology

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## Horizontal Gene Transfer

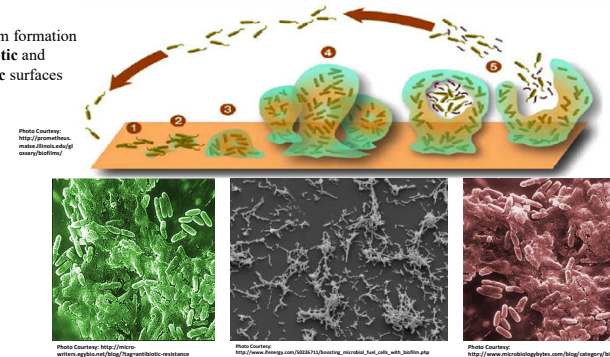


Donn, 2012

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## Planktonic cells and Biofilm Communities

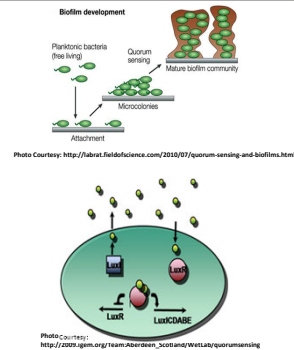
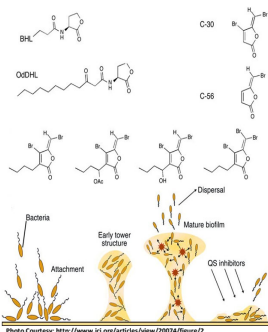
Biofilm formation on biotic and abiotic surfaces



66

## Quorum Sensing and Biofilm formation

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



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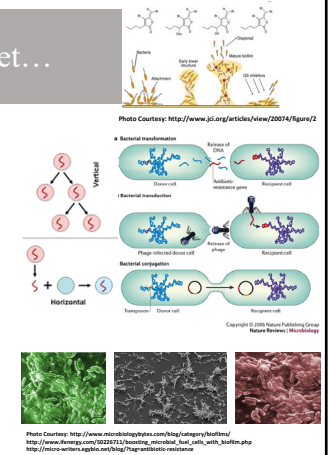
## Infectious Diseases is a Moving Target...

- It is estimated only 1% of microbial community has been identified.
- Currently **etiologial agent** of 80.3% of foodborne illnesses, **56.2% of hospitalization**, and 55.5% of deaths remain unknown (in a typical year, Scallan et al., 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



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## 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.

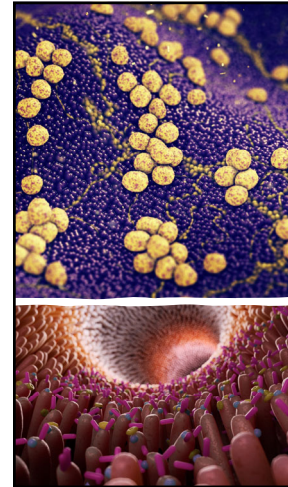
More recent estimates show: (Scallan et al., 2011)

- 47.8 million illnesses, 127,839 hospitalizations, and more than 3,037 deaths in the United States.
- 9.4 million illnesses, 55,961 hospitalizations, and 1,351 deaths are caused 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 YOPPs: 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



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## Water Safety Study

microorganisms

MDPI

**Fate and Biofilm Formation of Wild-Type and Pressure-Stressed Pathogens of Public Health Concern in Surface Water and on Abiotic Surfaces**

Md Niamul Kabir<sup>1</sup>, Saifur Anwar<sup>1</sup>, Sabina Wadood<sup>1</sup>, Shahid Chowdhury<sup>1</sup> and Aliyar Cyrus Faridulhake<sup>1,2\*</sup>

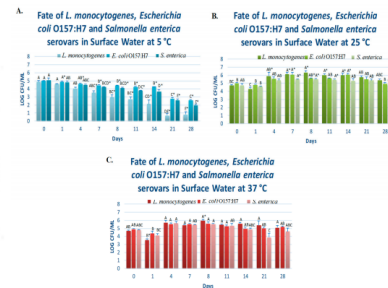
<sup>1</sup> Public Health Microbiology Laboratory, Tennessee State University, Nashville, TN 37208, USA; <sup>2</sup> Infectious Disease Research Center, Tennessee State University, Nashville, TN 37208, USA; <sup>3</sup> School of Public Health, Tennessee State University, Nashville, TN 37208, USA; \* Correspondence: aliyar.faridulhake@tsu.edu; Tel.: +1-615-489-7392

Received: 18 February 2020; Accepted: 13 March 2020; Published: 13 March 2020

### 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.**



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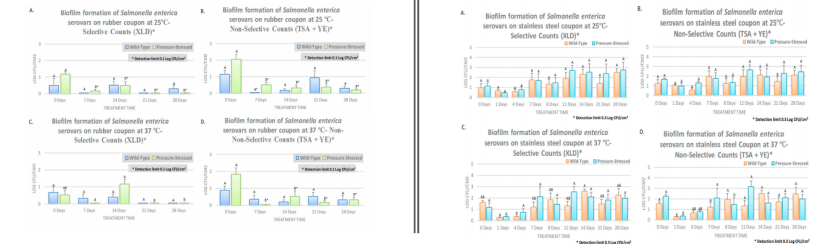
## Water Safety Study- Biofilm Formation on Abiotic Surfaces

Microorganisms 2020, 8, 408

9 of 14

Microorganisms 2020, 8, 408

11 of 14



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# 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 <sub>w</sub>	0.94	0.99	>0.99
Other	Non-spore former		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2<sup>nd</sup> 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



# Vibrio spp.

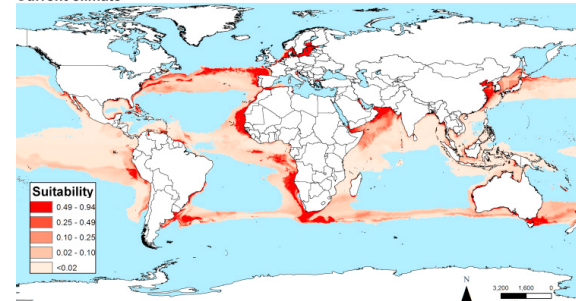
Currently 760,000 global illness/24,000 death per year.

- 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 <sub>w</sub>	0.94	0.98	0.996 (10% NaCl)
Other	Non-sporeformer, requires salt		

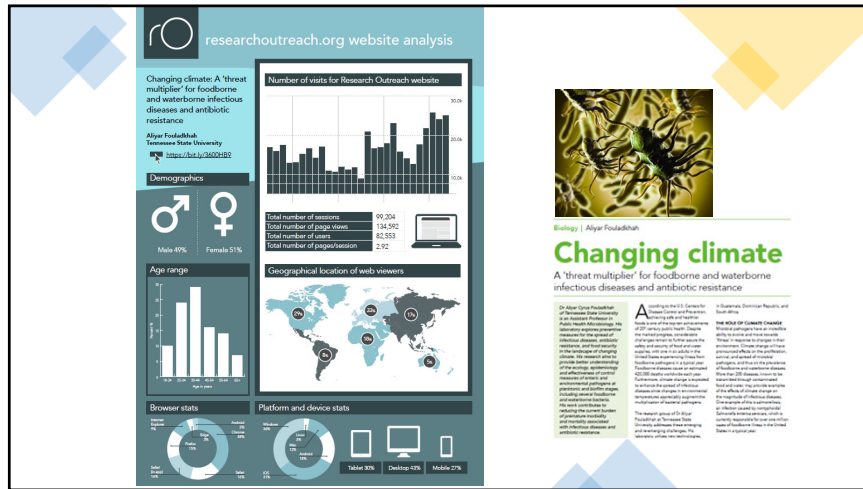
# Vibrio cholerae proliferation in sea water: Current Climate

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



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





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## Exercise one

- In your opinion, in what capacity the climate change will impact the local communities?
- What can an individual do in personal life to minimize the impact of climate change?
- What policies and regulations could be implemented in the food industry to minimize the negative impacts of the climate?

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Thank you!

Dr. Alyyar Cyrus Fouldkhah  
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Website: <http://publichealthmicrobiologyeducation/>

Contributions of members of the Public Health Microbiology Laboratory is gratefully acknowledged. Funding supports of the program leaders are additionally gratefully acknowledged.

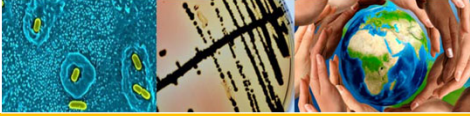
Ask Cyrus!?

Public Health Microbiology Laboratory

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

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## Foodborne Diseases of Public Health Importance and Transboundary Diseases

**Public Health and Food Safety Workshop, Haiti**  
3-24-2022

*Aliyar Cyrus Fouladkhah, PhD, MS, MPH, CFS, CPH*  
Faculty Director, Public Health Microbiology Laboratory

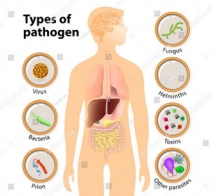


1

## Anthrax

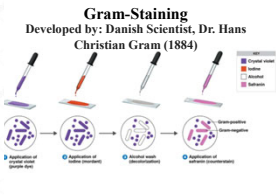
- Causative agent: *Bacillus anthracis*
- A **Gram-positive** and **spore-forming** bacteria
- Can be found as a spore in the **soil worldwide**
- Spores **viable for decades in soil**
- **In the US:** Dakotas, northwest Minnesota, Texas, and Nevada
- Common in parts of Africa, Asia, and Middle East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

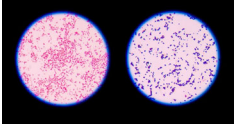
### Types of pathogen



### Gram-Staining

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






2

## 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



3

## 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**



4

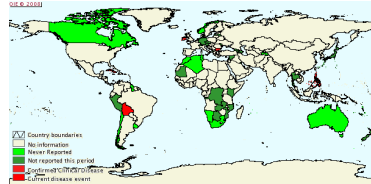
## Pseudorabies

- Contagious viral diseases from herpes family
- Primary concern in domesticated pigs and feral swine (around 75 million hogs in the United States in 2021)
- Primarily spread through direct animal-to-animal (nose-to-nose)
- Other mammals
  - Reproductive
  - Nervous system
- Humans are not affected
- Could be a ubiquitous virus in some area
- Eradicated in many countries
  - Still occurs in parts of world
- Current USDA Surveillance to detect any potential case



-Different than rabies that is an important zoonotic diseases.  
 -Rabies death in the U.S. now < 5 per year  
 -About 59,000 annually worldwide (>98% from stray dogs)

Source: CDC, 2021



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## Pseudorabies

- **Transmission:**
  - Direct contact,
  - Reproductive,
  - Aerosol,
  - Ingestion
- **Incubation period: 2-6 days**
- Common symptoms:
  - Neurological
  - Respiratory issues
  - Itching intensively
  - Stillbirths and abortion
- **Morbidity and mortality up to 100%**
- Neonates are particularly susceptible to the virus



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## Pseudorabies

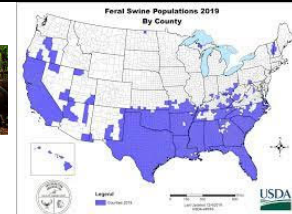
- Considered a reportable disease
- Could lead to economic and trade restrictions
- Treatment usually not recommended
- Current control practices:
  - Depopulation of the diseased
  - Test and removal of carries
  - Offspring segregation
- Vaccine available in some countries for affected animals



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## Prevention of Pseudorabies

- **Isolation:** new or returning animals before entry into the herd
- **Disinfect** vehicles, equipment, premises, footwear
- Separation of pigs and feral swine
- USDA extensive surveillance program
  - All 50 states are current free since April 2008 (commercially)
  - Feral swine remain as a reservoir of the pathogen



Source: USDA APHIS accessed 2021

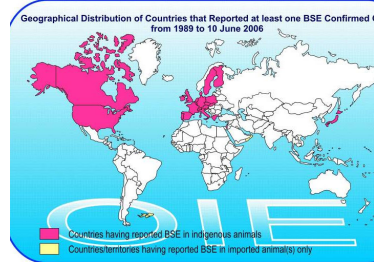


8

## 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

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## Brucellosis

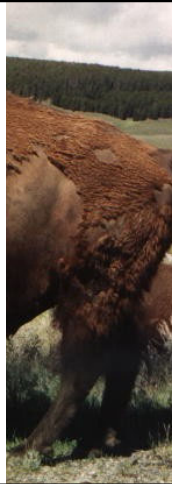
- Caused by bacteria (several species)  
(Genus *Brucella* e.g. *B. melitensis*, *B. abortus*, *B. suis*, and *B. canis*)
  - **Highly infectious** (N95 or KN95 mask during farm visits?)
  - Easily aerosolized
- **Transmission:**
  - Ingestion
  - Inhalation
  - Direct contact
- **Signs in animal:**
  - Reproductive complications
- **Signs in humans:**
  - Cyclic fever and
  - Flu-like symptoms



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## Brucellosis- Treatment & Prevention

- Treatment: long-term antibiotics (Problem: Diversity of causative agents)
  - Prevention:
    - Vaccination of calves
    - Minimizing exposure to wildlife
    - Segregation of infected animals
    - Disinfection of environment
  - No vaccine available for human
- Main infection source for human:**
- Contaminated milk, cheese, and ice-creams
  - Handling farm animals (glove, goggles, secondary outfit +mask?)
  - Hunting Activities



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## Equine Encephalitis Viruses



- Three viruses:
  - Eastern (EEE)
  - Western (WEE)
  - Venezuelan (VEE)
- Transmitted by mosquitoes (**vector-borne disease**)
- **Birds** could be **asymptomatic carrier**
- **Clinical signs** in human and Equids (Horses, mules, donkeys)
  - No to mild signs to
  - Flu-like illness
  - Encephalitis in small proportions
  - **Can also infect a wide range of animals including:** mammals, birds, reptiles, and amphibians

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## Equine Encephalitis Viruses

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



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## Hendra Virus

- Viral disease **consider as emerging** (first observed in Australia)
- Natural infections had been **reported only** in:
  - Horses
  - Humans (first reported in 1994, very rare and under-reported)
- Current transmission by:
  - Fruit bats
  - **Bodily fluids and urine** of those infected
- Clinical signs in horses
  - Sudden respiratory signs
  - Nasal discharge
  - Fever
  - Encephalitis
  - Sudden death
- Clinical signs in Humans
  - Flu-like illness
  - respiratory complications
  - **Highly fatal in human, could be as high as 2 in 3 cases**




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## Hendra Virus



- Little is known about pathogen
- **People at risk:**
  - Those occupational or recreational exposure to horses
  - Those living close to "Flying fox" bats (genus *Pteropus*)
  - Researchers
- Highest level of security (CDC biosafety level 4) needed for studying the pathogen (around 4 labs in the US and <50 in the world, as of 2021 [US has about 1,500 BSL3])
- Could cause high mortality in humans
- Currently no treatment option is available

*(Great topic for term paper)*

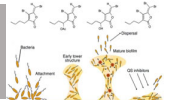


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# Main Bacterial Pathogens Associated with Animal and Human Health Diseases

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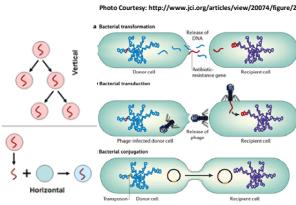
## Infectious Diseases in Animals and Human is a Moving Target...



- 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.gi.org/articles/view/20074/figure/2>

Photo Courtesy: <http://www.microbiologybytes.com/blog/category/biotechnology/>  
[http://www.emergent.com/2022/01/21/emerging\\_microbial\\_suit\\_suits\\_suits\\_microbes.php](http://www.emergent.com/2022/01/21/emerging_microbial_suit_suits_suits_microbes.php)  
<http://micro-writers.eggbot.net/blog/?tag=antibiotic-resistance>

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

BY REEEN BRANNIELL, SMV January 13, 2017

Rare strains of E. coli have been confirmed in three Canadian provinces, according to a warning posted on the website of the Public Health Agency of Canada. The Public Health Agency of Canada reports that of the rare strains were confirmed in British Columbia, New Brunswick and Nova Scotia. The agency says that the strains are highly resistant to antibiotics.

Photo of the superbug has been hospitalized. The superbug has been confirmed in three Canadian provinces, according to a warning posted on the website of the Public Health Agency of Canada. The Public Health Agency of Canada reports that of the rare strains were confirmed in British Columbia, New Brunswick and Nova Scotia. The agency says that the strains are highly resistant to antibiotics.

### New outbreaks linked to Italian style meats; one third of patients hospitalized

By Lisa Brannan on August 24, 2017

Salmonella are leading the specific number of cases with salmonella outbreaks that have been associated with Italian-style meats. These meats are popular from 17 states have been confirmed with the fat.

### Almost 200 sick in UK-wide Salmonella outbreak

By Lisa Brannan on August 24, 2017

Nearly 200 people across the United Kingdom are part of a Salmonella outbreak linked to some raw eating products.

### Multidrug-resistant salmonella outbreak characterized

By Lisa Brannan on August 24, 2017

Photo Courtesy: <http://www.cdc.gov/media/releases/2017/s170824-salmonella.html>

### CDC says outbreak traced to raw clover sprouts has come to an end

By Lisa Brannan on April 23, 2016

The Food and Drug Administration's investigation of an outbreak of E. coli 2016:03

### Eat Smart chopped salad kit recalled in Canada over Listeria concerns

By Lisa Brannan on August 24, 2017

Canadian Food Inspection Agency has issued a recall and quarantine of Eat Smart Chopped Salad Kit because of possible Listeria monocytogenes contamination.

### Raw goat milk recalled because of positive test for Campylobacter

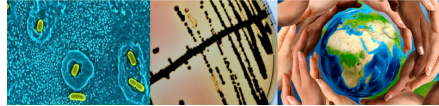
By Lisa Brannan on August 24, 2017

Some of the goat milk has been found to contain a small amount of Campylobacter and because tests have shown it can be contaminated with Campylobacter.

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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 <sub>w</sub>	0.94	0.99	>0.99
Other	Non-spore former		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2<sup>nd</sup> 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



### Salmonella Outbreaks Linked to Backyard Poultry

Investigation Notice

Posted July 23, 2021

One in four sick people is a child younger than 5 years. Don't let young children touch chicks, ducklings, or other backyard poultry.

#### Fast Facts

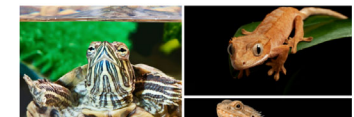
- Illnesses: 672 (198 new)
- Hospitalizations: 157 (54 new)
- Deaths: 2 (1 new)
- States: 47 (1 new)
- Investigation status: Active



### Pet Turtles: Cute But Commonly Contaminated with Salmonella

Turtles commonly carry bacteria on their outer skin and shell surfaces that can make people very ill. Geckos and bearded dragons can also infect people.

Share this Post: Facebook Twitter LinkedIn Email Print



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## Staphylococcus aureus

### Foodborne Diseases

- Infection
- Intoxication
- Toxicoinfection

- **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 <sub>w</sub>	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 2<sup>nd</sup> edition, Scallan et al. 2011, and FSPCA

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## Campylobacter spp.

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

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

Sources: ICMSF 1995 and Bad Bug Book 2<sup>nd</sup> edition and FSPCA

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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**

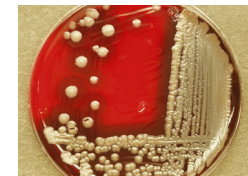
Growth parameters	Minimum	Optimum	Maximum
Temperature	39°F (4°C)	82-95° F (28-35°C)	131°F (55°C)
pH	4.3	6.0-7.0	9.3
a <sub>w</sub>	0.92	-	-
Other	Spore former; toxin is heat stable		
Atmosphere	Facultative – grows with or without oxygen		

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	<b>44°F (6.5°C)</b>	95-104°F (35-40°C)	121°F (49.4°C)
pH	4	6-7	10
a <sub>w</sub>	0.95	0.995	-
Other	Non-spore forming		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMF 1995 and Bad Bug Book 2<sup>nd</sup> 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	<b>41°F (5°C)</b>	99°F (37°C)	114°F (45.3°C)
pH	4.8	7.8-8.6	11
a <sub>w</sub>	0.94	0.98	0.996 (10% NaCl)
Other	Non-sporeformer, <b>requires salt</b>		
Atmosphere	Facultative - grows with or without oxygen		

Sources: Seafood Hazards Guide 2011, ICMF 1995 and Bad Bug Book 2<sup>nd</sup> edition

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## *Yersinia enterocolitica*

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

Growth parameters	Minimum	Optimum	Maximum
Temperature	<b>30°F (-1.3°C)</b>	77-99°F (25-37°C)	108°F (42°C)
pH	4.2	7.2	10
a <sub>w</sub>	0.945	-	-
Other	Non-spore former, <b>raw milk in fridge?</b>		
Atmosphere	Facultative - grows with or without oxygen		

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

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## Listeria monocytogenes

- **Infection causes** severe illness in susceptible people – **mortality 15-30%**
- **Primary sources:** Occurs widely in agriculture (soil, plants and water) –(**Important during pregnancy**)
- **Transmitted by:** Refrigerated **RTE foods** that support growth (**South Africa, Largest in History in 2018**)
- **Contributing factors:** Environmental pathogen spread by environmental contamination, equipment, people, incoming raw ingredients (**ubiquitous in nature**)
- **Common in domesticated ruminants** 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 <sub>w</sub>	0.92	-	-
Other	Non-sporeformer		
Atmosphere	Facultative - grows with or without oxygen		

Sources: ICMSF 1995 and Bad Bug Book 2<sup>nd</sup> 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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### Outbreak Investigations & Safety Advisories Center for Food Safety and Applied Nutrition

The following is an update from FDA of concern to our subscribers.

#### FDA Investigation of Cronobacter Infections: Powdered Infant Formula

March 22, 2022

The FDA, along with CDC and state and local partners are investigating consumer complaints and/or reports of infant illness related to products from Abbott Nutrition's Sturgis, MI facility. All of the ill patients are reported to have consumed powdered infant formula produced from Abbott Nutrition's Sturgis, MI facility.

The FDA is releasing the FDA Form 483s from three inspections conducted at Abbott Nutrition's facility on Sept. 16-24, 2019, Sept. 20-24, 2021, and Jan. 31-March 18, 2022. The inspectional observations

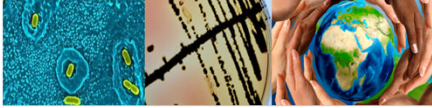
35

Thank you!

**Dr. Aliyar Cyrus Fouladkhah,**  
Faculty Director, Public Health Microbiology Laboratory, Tennessee State University  
[afouladk@tnstate.edu](mailto:afouladk@tnstate.edu)  
Phone: (970) 690-7392

Photos Courtesy: Adobe Stock, royalty purchased (standard) licensed by public health microbiology laboratory.

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**Food Safety  
Modernization Act  
Certification**

[3-22-2022]

**Aliyar Cyrus Fouladkhah**  
**Public Health Microbiology Laboratory**  
**Cooperative Extension Program**  
**Tennessee State University**

1



**Food Safety Modernization Act (FSMA)**

---

- Signed to law in January of 2011, FSMA is the largest expansion of U.S. food safety authorities since the 1930s.
- Many sectors of agriculture and manufacturing will undergo strict regulations for the **first time in the history of the country.**
- Shifting responses from food safety problems to **proactively prevent** the episodes
- FSMA, a large and comprehensive legislation **broaden FDA's ability** to:
  - **Mandatory recall** of contaminated food products
  - **Enhanced surveillance** to investigate foodborne illness outbreaks
  - Established **new preventive controls** and food safety plans at some food processing facilities and farms
  - Enhanced FDA's **traceability capacity**
  - **Increased inspection** frequencies of high-risk food facilities (both domestic and foreign facilities)
  - Expanded authority and oversight capabilities with regard to **foreign companies**

2

**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




3

**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.**



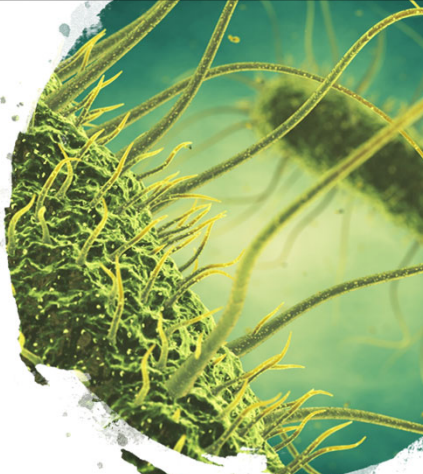
4

## 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 publically 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](#).




5

## 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.**



6

## Preventive Control for Human Food Rule: Overview (PC QI)

- Regulate "processors"
- Under the regulation all "facilities" have to be registered with FDA
- The rule has **two sections: Hazard Analysis (HARPC) and GMP**, facilities obligated to have one or both.
- **Exemptions:** Juice, seafood, and shell egg sectors and businesses that store agricultural commodities. (differs with preventive rule)

**Modified Requirements:**

- Three-year average sales less than \$500K, AND
  - Direct sales to restaurants and consumers within 275 mile radius, or
  - Within states sales in 275 mile radius.



7

## Requirements of Preventive Rule cGMP-Current Good Manufacturing Practices


- Similar to prerequisite program in HACCP
- **Nearly all facilities are required** to follow this section of the rule

**Exemption:**

- (1) Businesses that store agricultural commodities
- (2) Businesses that selling directly to a manufacturing facility like canning operation (vertically integrated farms)

**Main Principles:**

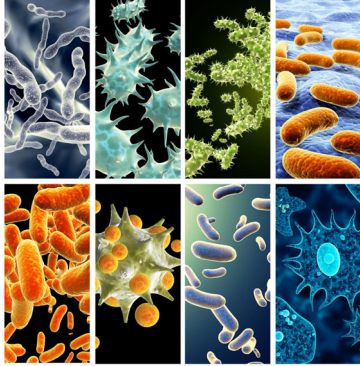
- Sanitation
- Employee training
- Environmental control and training
- Recall contingency plan
- Allergen control
- Supplier verifications
- Sanitary transportation



8

### Requirements of Preventive Rule Hazard Analysis and Risk-Based Preventative Controls (HARPC)

- Previous a 7-step plan for FSIS HACCP, 12-step plan for Codex HACCP, and currently 5-step plan for HARPC:
- **Hazard analysis**
- Identification and implementation **preventive controls**.
- **Monitoring** the performance of controls.
- Developing **corrective actions** for preventative deviation.
- **Verification and recordkeeping** of preventative controls effectiveness
- 2.5 day workshop Preventive Control Qualified Individuals (PC QI)



9

### Preventive Rule: Implementation and compliance dates

- **Implementation date:** August 30, 2015
- **Compliance date:**
  - **Very small facility** (\$2.5\*m and below): 3 year
  - **Small facility** (less than 500 employee and does not qualified for exception): 2 years
  - **“Other” facilities:** 1 years

**Modified Requirements:**

- Three-year average sales less than \$500K, AND
  - Direct sales to restaurants and consumers within 275 mile radius, or
  - Within states sales in 275-mile radius.


\*Total annual sale; the categories differ in preventive and produce rules.

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### Preventive Control for Human Food: PC QI

Human Food	Valerie Charost	Nov 2, 2022	Register	CAD 995	Contact	Live-Virtual Quebec Canada	French	Virtual - Online Web Based Live
Human Food	Valerie Charost	Mar 2, 2022	Register	CAD 995	Contact	Live-Virtual Quebec Canada	French	Virtual - Online Web Based Live
Human Food	Valerie Charost	Jun 15, 2022	Register	CAD 995	Contact	Live-Virtual Quebec Canada	French	Virtual - Online Web Based Live
Human Food	Cynthia Weber	Dec 27, 2021	Register	USD 799	Contact	Self-Faced, Online, English, Walk at Your Own Pace in CHINESE	Chinese	Virtual - Online Web Based Live
Human Food	Cynthia Weber	Dec 6, 2021	Register	USD 799	Contact	Self-Faced, Online, English, Walk at Your Own Pace in ENGLISH	English	Virtual - Online Web Based Live
Human Food	Oscar Camacho	Jan 26, 2022	Register	USD 775	Contact	Napa CA United States	English	Virtual - Online Web Based Live
Human Food	Matt McClure	Mar 21, 2022	Register	USD 799	Contact	No Travel Live Instructor in Real Time United States	English	Virtual - Online Web Based Live
Human Food	Cynthia Weber	Dec 6, 2021	Register	USD 799	Contact	en linea 100% a su propio ritmo España en cualquier momento United States	Spanish	Virtual - Online Web Based Live
Human Food	Cynthia Weber	Dec 20, 2021	Register	USD 799	Contact	en linea 100% a su propio ritmo España en cualquier momento United States	Spanish	Virtual - Online Web Based Live

- Our course 3-21-2022 to 3-25-2022
- Thank you:



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### FSPCA PREVENTIVE CONTROLS FOR HUMAN FOOD

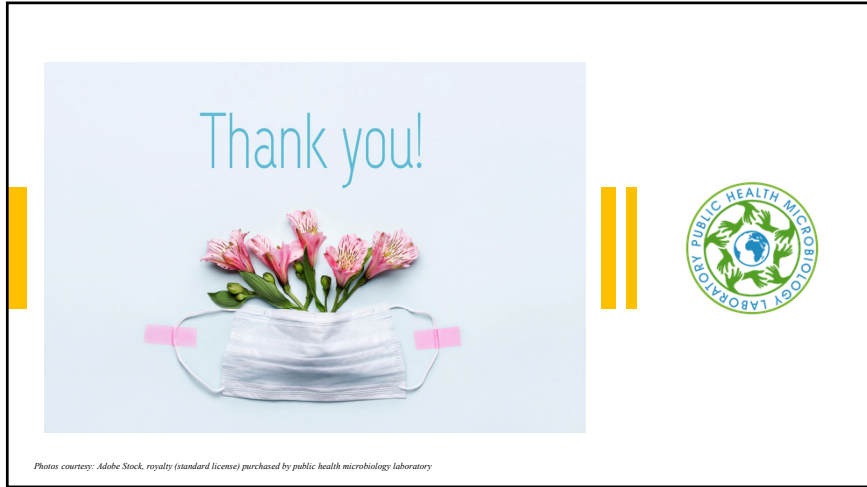
Exercise Workbook  
Including Food Safety Plan Worksheets

Developed by the  
**FSPCA**  
FOOD SAFETY PREVENTIVE CONTROLS ALLIANCE

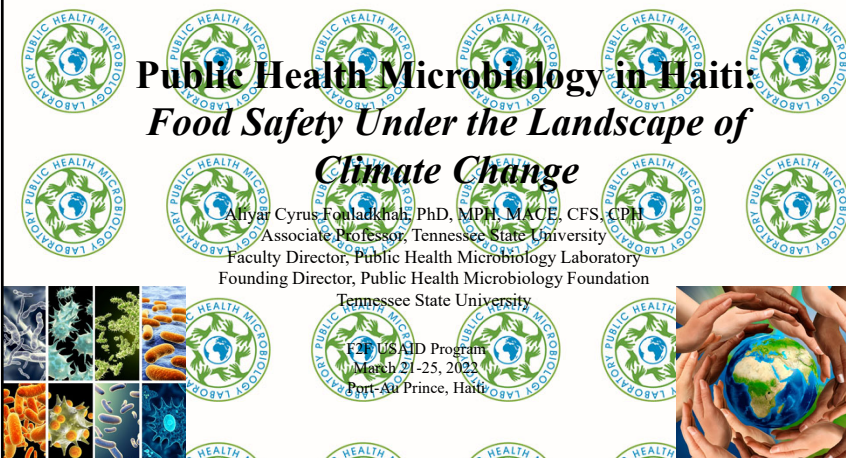


**Participant Manual**  
First Edition - 2016

12



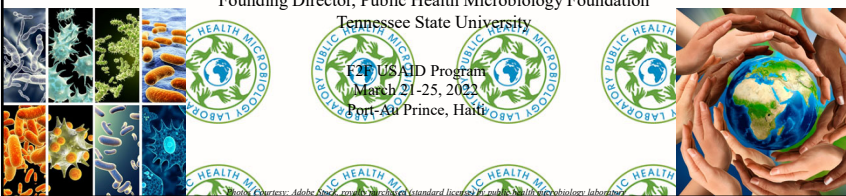
Photos courtesy: Adobe Stock, royalty (standard license) purchased by public health microbiology laboratory



## Public Health Microbiology in Haiti: Food Safety Under the Landscape of Climate Change

Aliyar Cyrus Fouadkhalil, PhD, MPH, MACE, CFS, CPH  
Associate Professor, Tennessee State University  
Faculty Director, Public Health Microbiology Laboratory  
Founding Director, Public Health Microbiology Foundation  
Tennessee State University

US AID Program  
March 21-25, 2022  
Port Au Prince, Haiti



1



## Brief Introduction to my Program

2

- Microbiology and Food Safety, PhD (CSU Animal Science Dept.)
- Applied Statistics and Data Analysis, Graduate Certificate (CSU Statistics Dept.)
- Food Science & Human Nutrition, MS (CSU Food Science Dept.)
- Food Science and Technology, BS, National University of Iran.

## Yale SCHOOL OF PUBLIC HEALTH

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





Advanced Professional MPH Program






Website: <https://publichealth.yale.edu/education/degrees/ MPH/advanced>  
Video: <https://www.youtube.com/watch?v=IGVNBf0t8>




3


## Public Health Microbiology Laboratory Tennessee State University

MPH Curriculum Food Safety and Applied Epidemiology (now under CEPH certification)






- ❖ Secured extramural support >\$3.4M as PD or Co-PD since 2015
- ❖ **T&P** applications both approved, will be effective July 31, 2021.
- ❖ **Funding sources**
- (1) **Dean's Office:** \$7,000/year and a Research Technician
- (2) **Association of Food and Drug Officials (AFDO)** Process Authority: \$15-50K per year depending on the projects
- (3) **Extramural Funding:** >\$3.4M since 2015
  - ❖ 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)

Website: <https://publichealthmicrobiology.education/>



**PROSPECTIVE STUDENTS, EDUCATORS, AND STAKEHOLDERS**



Website performance: 4/22/2020

\* Pending account setting and internal administrative approval.  
\*\* Sub-recipient of Southern Farmer, India Awards.

4

## Public Health Microbiology Laboratory Current Members

**Current Graduate Students (Primary Advisor/Degree Chair: A. Fouladkhah):**

- Sudive Aras (2018-),** Graduate Research Assistant, (PhD candidate, Biological Sciences c. Food Microbiology)
- Jothi George (2019-),** Graduate Research Assistant (PhD student, Biological Sciences c. Food Microbiology)
- Sabrina Wadood (2020-),** Graduate Research Assistant (MS student, c. Food Microbiology)

**Current Dean Scholar/Undergraduate Students:**

- Akilyah Sumlin\* (2018-),** *Dean Scholar/Undergraduate Research Assistant*
- Simen Asefaw (2019-),** *Undergraduate student (adviser for senior project)*
- Kennedy Miller (2020-),** *Undergraduate student (adviser for senior project)*

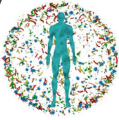



**Current Research Technician, Associates, and Interns (Primary Supervisor: A. Fouladkhah):**

- Mr. Shahid Chowdhury\*,** Research Technician (2016-present)
- Dr. Niamal Kabir, PhD,** Post-doctoral Research Associate (2018-2021).
- Ms. Amir Kashinpa, MS,** Data Visualization Intern and Web Editor (2018-present).
- Dr. Naraghi, PhD, MSPH,** Visiting Scholar (2020-present).

**Current Graduate Student Committee:**

- Sareva Singh Humal, PhD candidate,** Biological Sciences con. Food Microbiology (Committee member).
- Yan Tian, PhD student,** Biological Sciences con. Genomics & Immunology (Committee member).
- Zedonta Williams, MS student,** M.S. degree in Food and Animal Sciences (Committee member).

\* Supported by office of the Dean

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## Students Awards Adviser: A. Fouladkhah > 45 awards and Scholarships (2017-2020)

Students Success Available at: <https://publichealthmicrobiology.education/students-awards>

**Public Health Microbiology Laboratory**



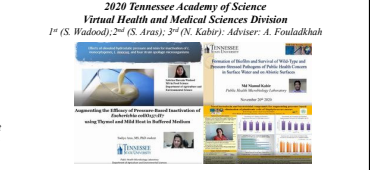
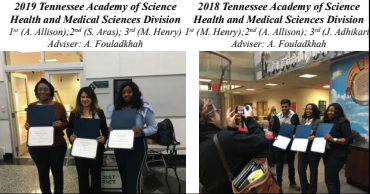
**2020 Tennessee Academy of Science  
Virtual Health and Medical Sciences Division**  
1<sup>st</sup> (S. Wadood), 2<sup>nd</sup> (S. Aras), 3<sup>rd</sup> (N. Kabir); Adviser: A. Fouladkhah

**2019 Tennessee Academy of Science  
Health and Medical Sciences Division**  
1<sup>st</sup> (A. Allison), 2<sup>nd</sup> (S. Aras), 3<sup>rd</sup> (M. Henry) 1<sup>st</sup> (M. Henry), 2<sup>nd</sup> (A. Allison), 3<sup>rd</sup> (J. Adhikari); Adviser: A. Fouladkhah

**2018 Tennessee Academy of Science  
Health and Medical Sciences Division**  
1<sup>st</sup> (M. Henry), 2<sup>nd</sup> (A. Allison), 3<sup>rd</sup> (J. Adhikari); Adviser: A. Fouladkhah

**A. Allison, Outstanding PhD Student in College of Agriculture, Receiving an Award from Dean Reddy.**

**M. Henry (2<sup>nd</sup> from left), Outstanding MS Student in College of Agriculture, Received an Award from Dean Reddy.**

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Available at: <https://publichealthmicrobiology.education/annual-competitions>

## Annual State-Wide Competitions For Food Safety Modernization Act, Food Safety and Infectious Disease Students

**A. Fouladkhah: Competition Founder and Director**

**4th (2020) Annual State-Wide Competition for Food Safety Modernization Act, Food Safety, and Food Science Students**

Emerging Leaders Category:  
First Place (Hon): Dr. Umar Ibrahim, Tennessee State University (Award: \$300)  
First Place (Hon): Dr. Umar Ibrahim, Tennessee State University (Award: \$300)  
Second Place: Dr. Md Niamal Kabir, Tennessee State University (Award: \$200)  
Third Place: Not awarded this year.

Finalists in Oral Competition for Students:  
First Place: Ashish Vankar, Tennessee State University (Award: \$400)  
Second Place: Joshi George, Tennessee State University (Award: \$200)  
Third Place: Sabrina Aras, Tennessee State University (Award: \$200)

Finalists in Poster Competition for Students:  
First Place: Ashish Vankar, Tennessee State University (Award: \$500)  
Second Place: Anika Chowdhury, Middle Tennessee State University (Award: \$250)  
Third Place: Shreya Shetty, Tennessee State University (Award: \$100)  
Third Place (Hon): Ashish Vankar, Tennessee State University (Award: \$100)

**3rd (2019) Annual State-Wide Competition for Food Safety Modernization Act, Food Safety, and Food Science Students**

2019 Graduate Oral Competition Winners:  
1st Place (Hon): Shreya Shetty, TSI  
1st Place (Hon): Umar Ibrahim, TSI  
2nd Place: Ashish Vankar, TSI  
3rd Place: Shreya Shetty, TSI

2019 Graduate Oral Competition Winners:  
1st Place (Hon): Anika Chowdhury, TSI  
1st Place (Hon): Joshi George, TSI  
2nd Place (Hon): Shreya Shetty, TSI  
2nd Place (Hon): Umar Ibrahim, TSI  
3rd Place: Anika Chowdhury, TSI


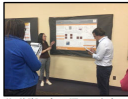
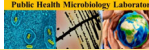
**2nd (2018) Annual State-Wide Competition for Food Safety Modernization Act, Food Safety, and Food Science Students**

2018 Graduate Competition Winners:  
1st Place (Hon): Shreya Shetty, TSI  
1st Place (Hon): Umar Ibrahim, TSI  
2nd Place (Hon): Umar Ibrahim, TSI  
2nd Place (Hon): Umar Ibrahim, TSI  
3rd Place: Umar Ibrahim, TSI

**2017-2020: 31 funded award (extramural grants of A. Fouladkhah)**

**Current AFRI Application Pending**

Public Health Microbiology Laboratory

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## Teaching in Tennessee and Internationally

**International Travel Reports Available at:** <https://publichealthmicrobiology.education/international-programs>

**2021, 2022 Jamaica November 2021**

**2020, 2022 Haiti (Distant Appointment) Haiti Government, Fortification with iron, vitamin b12, and zinc**

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

**2018 & 2020, 2200 Guatemala Food Safety Training for Food Industry Leadership**

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

**2020 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 TSI!"

**2019 Student Evaluation:**

"Dr. Fouladkhah is an excellent professor. He does the absolute best job of making students feel comfortable making discussion in class and is exceptionally knowledgeable in the area of food sciences. The in class exercises are definitely helpful to make sure the lectures are being retained and assists in requiring little to no studying outside of the class meetings."



"This course is top notch, one of the best courses I have ever taken. Much gratitude to the lead instructor Dr. Fouladkhah. I learned so much in the class and my knowledge on food policies and regulation has increased a thousandfold."



"Everything was well organized, I think it is perfect. Nothing else is needed."

**2018 Student Evaluation:**

"This man is so amazing. Learned so much in his class thank you Dr. Fouladkhah."

"He is very helpful and always very encouraging. He helped me planned my studies and even future goals."

8

### Process Authority, Variance Committee, PC QI Certifications

(1) **Process Authority**, for state of Tennessee

- List of current 63 process authorities: <https://www.afdo.org/directories/tpa/>

(2) Additionally, Serve on State **Variance**

*"Variance" means a written document issued by the REGULATORY AUTHORITY that authorizes a modification or waiver of any requirements of this Code if, in the opinion of the REGULATORY AUTHORITY, a health HAZARD or nuisance will not result, modification or waiver.*


Serving as FSPCA Lead Instructor since 2016:

(3) **Preventive Control Qualified Individual (PC QI) Certifications**. Meeting requirements drug administration.

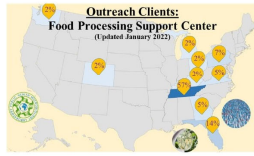



9


### Food Processing Support Center of Public Health Microbiology Foundation



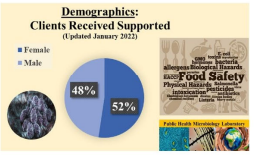
**Outreach Clients:**  
Food Processing Support Center  
(Updated January 2022)



**Stakeholder Profile:**  
Food Processing Center Clients  
(Updated January 2022)



**Demographics:**  
Clients Received Supported  
(Updated January 2022)



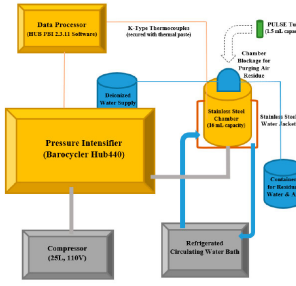
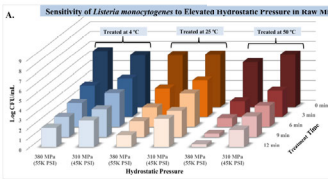
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### Research Responsibility:

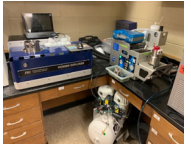
- Elevated Hydrostatic Pressure
- Bacterial Biofilm
- Effects of Climate Change on infectious disease

**PBI Pressure BioSciences Inc.**

- Elevated Hydrostatics Pressure:
- Hub880, up to **650 MPa**
- Deepest part of Oceans (Mariana Trench): c. **110 MPa**
- Programmable unit Hub 440, 380 MPa
- Controlling the temperature
- Synergism with bacteriocin and bactericidal compounds

Alison et al., 2018



High Pressure Processing, Public Health Microbiology Laboratory

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

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## Coming Soon ...





**Ask Cyrus!?**

Answering Your Public Health Microbiology, Infectious Diseases, and Food Safety Questions

<https://publichealthmicrobiology.education/ask-cyrus>

High Pressure Processing, Public Health Microbiology Laboratory

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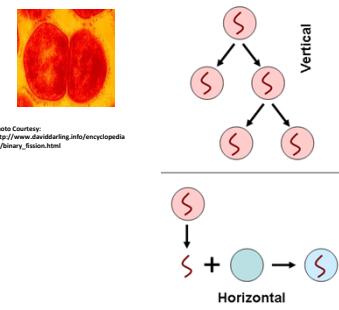
*Epidemiology of Foodborne Diseases*



13

### Emerging pathogens

*Vertical and Horizontal Gene Transfer and Emerging Pathogens*



**Vertical**

**Horizontal**

**a Bacterial transformation**  
 Donor cell → Release of DNA → Recipient cell → Antibiotic-resistance gene

**b Bacterial transduction**  
 Phage-infected donor cell → Release of phage → Recipient cell

**c Bacterial conjugation**  
 Transposon → Donor cell → Recipient cell

Photo Courtesy: [http://www.diseasesolving.info/encyclopedia/B/Binary\\_Fission.html](http://www.diseasesolving.info/encyclopedia/B/Binary_Fission.html)

Copyright © 2006 Nature Publishing Group  
 Nature Reviews | Microbiology

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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 <i>E. coli</i>	10 to 100 cells
<i>Cronobacter sakazakii</i>	10 to 100 cells
<i>Listeria monocytogenes</i>	<1000 cells
<i>Campylobacter</i> spp.	5000 to 10,000 cells
<i>Staphylococcus aureus</i>	>100,000 cells
<i>Vibrio cholerae</i>	1,000,000 cells

\* Calculated for oral ingestion based on epidemiological data from outbreaks and human feeding trials of volunteers. Data obtained from *ES of Food and Drug Administration (2nd edition)*.

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

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## Horizontal Gene Transfer

**(a) Conjugation:**  
 Resistant donor cell → DNA exchange through pilus → Non-resistant recipient cell → Resistant transconjugant cell

**(b) Transduction:**  
 Resistant, infected donor cell → Lysis, cell death → Phage carrying bacterial ARG → Transport to and infection of a non-resistant recipient cell → Resistant transductant cell (in lysogenic growth)

**(c) Natural transformation:**  
 Resistant donor cell → Cell death, lysis → Free DNA w/ intact ARG → Transport to and uptake by competent, non-resistant recipient cell → Resistant transformant cell

ARG (chromosomal or plasmid-borne)

Donn, 2012

16

### Planktonic cells and Biofilm Communities

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

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

#### Biofilm Formation and Decontamination of Wild-Type and Pressure-Stressed *Cronobacter Sakazakii*

Temperature: 25°C  
Treatment: Sodium Hypochlorite

Days and Treatment	Wild-Type (LOG CFU/CM <sup>2</sup> )	Pressure-Stressed (LOG CFU/CM <sup>2</sup> )
Day 0	~4.5 (D)	~4.5 (C)
Day 0 TRT	~1.5 (E)	~1.5 (d)
Day 1	~8.0 (A)	~8.0 (a)
Day 4	~8.0 (A)	~8.0 (a)
Day 7	~7.5 (A)	~7.5 (a)
Day 7 TRT	~5.5 (C)	~5.5 (b)
Day 8	~8.0 (A)	~8.0 (a)
Day 11	~8.0 (A)	~8.0 (a)
Day 14	~8.0 (A)	~8.0 (a)
Day 14 TRT	~6.0 (BC)	~6.0 (a)

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Allison et al., 2020

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### Quorum Sensing and Biofilm formation

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

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

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

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

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### Infectious Diseases 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.microworld.com/2007/04/24/quorum-sensing/>


Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

Photo Courtesy: <http://www.microworld.com/2007/04/24/quorum-sensing/>

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## Epidemiology of Foodborne Diseases


- Based on data from 1990s: (Mead et al., 1999)  
76 million illnesses, 323,000 hospitalizations, 5,200 deaths in the United States.
- More recent estimates show: (Scallan et al., 2011)  
47.8 million illnesses, 127,839 hospitalizations, and more than **3,037** deaths in the United States.
- 9.4 million illnesses, 55,961 hospitalizations, and 1,351 deaths are caused 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 YOP's: The young, the old, Pregnant, and Immunocompromised)



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

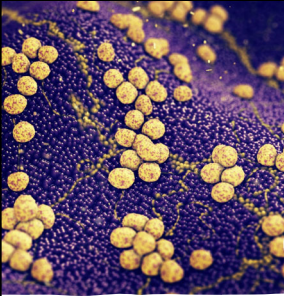
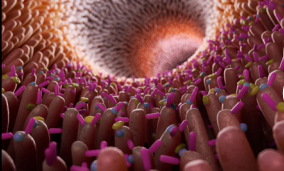
- Leading etiological agents for illnesses:** *Norovirus* (58%), Nontyphoidal *Salmonella* serovars (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp (9%).
- Leading etiological agents for hospitalization:** Nontyphoidal *Salmonella* serovars (35%), *Norovirus* (26%), *Campylobacter* spp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



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## Signs and Symptoms of Foodborne Diseases

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

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

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

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

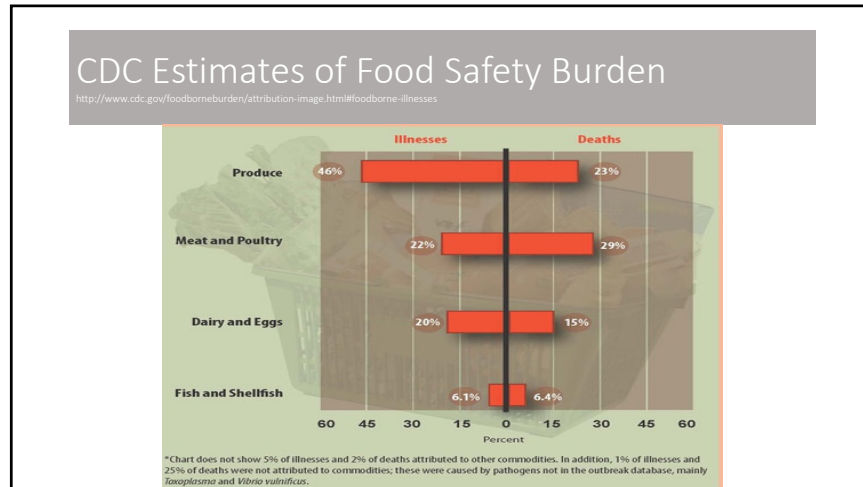
**DALY = YLL + YLD**

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

Source: WHO, 2019

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

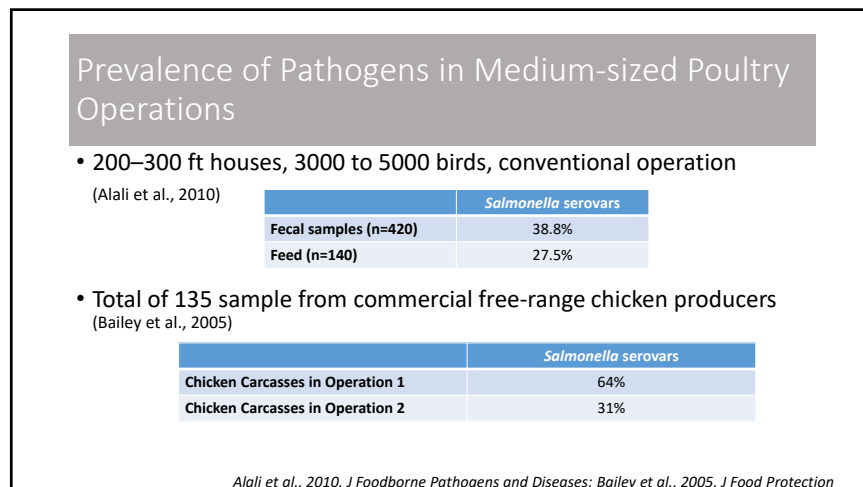
24



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Are these outbreaks associated with corporates and lager manufactures?

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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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# Water Safety Study



**microorganisms**

**Fate and Biofilm Formation of Wild-Type and Pressure-Stressed Pathogens of Public Health Concern in Surface Water and on Abiotic Surfaces**

Md Nissam Kabir<sup>1</sup>, Sadley Anon<sup>1</sup>, Sabina Wahed<sup>1</sup>, Shikhi Chowdhury<sup>1</sup> and Alijyar Cyrus FoadiBabab<sup>1,2\*</sup>

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Received: 18 February 2020; Accepted: 11 March 2020; Published: 11 March 2020

### Public Health Burden of Waterborne Disease

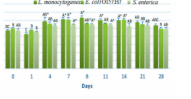
17 waterborne pathogens cause estimated: (Collier et al., 2021)

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

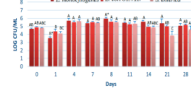
**A. Fate of *L. monocytogenes*, *Escherichia coli* O157:H7 and *Salmonella enterica* serovars in Surface Water at 5 °C**



**B. Fate of *L. monocytogenes*, *Escherichia coli* O157:H7 and *Salmonella enterica* serovars in Surface Water at 25 °C**



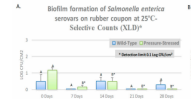
**C. Fate of *L. monocytogenes*, *Escherichia coli* O157:H7 and *Salmonella enterica* serovars in Surface Water at 37 °C**




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## Water Safety Study- Biofilm Formation on Abiotic Surfaces


**A. Biofilm formation of *Salmonella enterica* serovars on rubber coupon at 25 °C- Selective Counts (XLD)\***



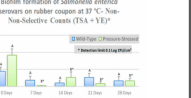
**B. Biofilm formation of *Salmonella enterica* serovars on rubber coupon at 25 °C- Non-Selective Counts (TSA + YE)\***



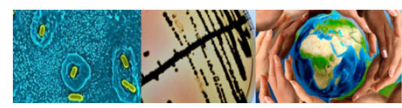
**C. Biofilm formation of *Salmonella enterica* serovars on stainless steel coupon at 25 °C- Selective Counts (XLD)\***



**D. Biofilm formation of *Salmonella enterica* serovars on stainless steel coupon at 25 °C- Non-Selective Counts (TSA + YE)\***




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## Impact of Climate Change on Foodborne and Waterborne Infectious Diseases

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## 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 <sub>w</sub>	0.94	0.99	>0.99
Other	Non-spore former		
Atmosphere	Facultative - grows with or without oxygen		

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

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## 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

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

Biological Sciences Education Resource Project

**microorganisms**  
Safety of Food and Water Supplies in the Landscape of Changing Climate

Alison Cross, Leah Kishor, Brian Thompson, and James Smith Camp

1. Food and Water Security, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

2. Food and Water Security, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

3. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

4. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

5. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

6. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

7. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

8. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

9. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

10. Department of Agricultural, Food and Forestry Sciences, 2017. Available at: <https://www.fao.org/3/ah6302e/ah6302e.pdf>

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## Vibrio spp.

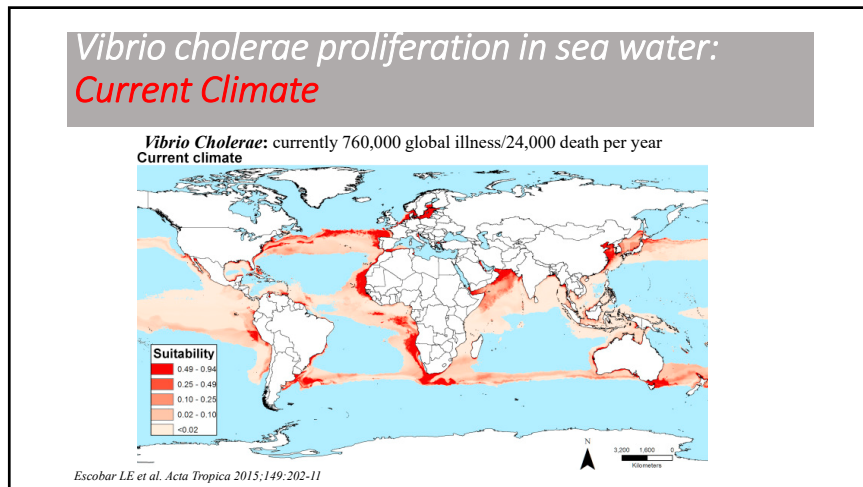
**Currently 760,000 global illness/24,000 death per year.**

- 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)

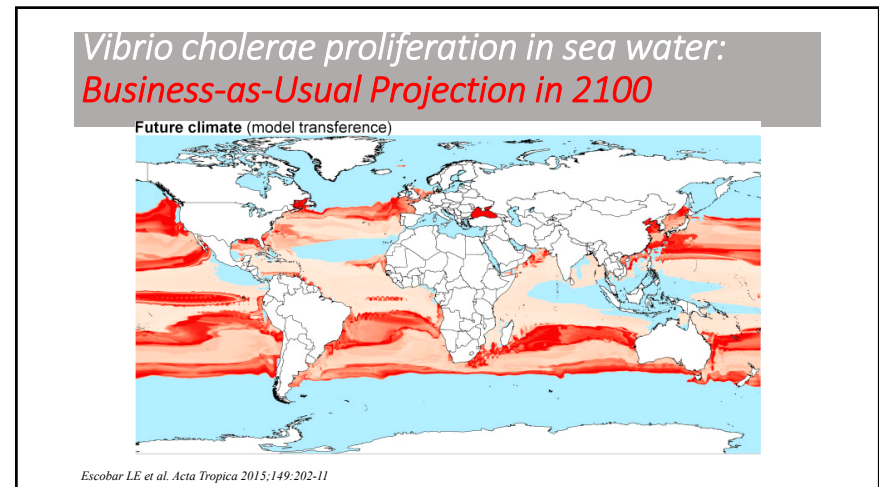
Growth parameters	Minimum	Optimum	Maximum
Temperature	41°F (5°C)	99°F (37°C)	114°F (45.3°C)
pH	4.8	7.8-8.6	11
a <sub>w</sub>	0.94	0.98	0.996 (10% NaCl)
Other	Non-sporeformer, requires salt		
Atmosphere	Facultative - grows with or without oxygen		

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

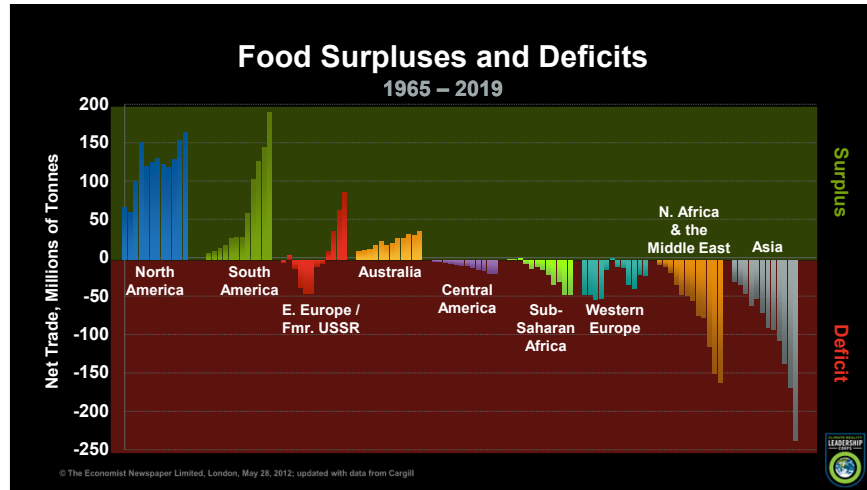
34



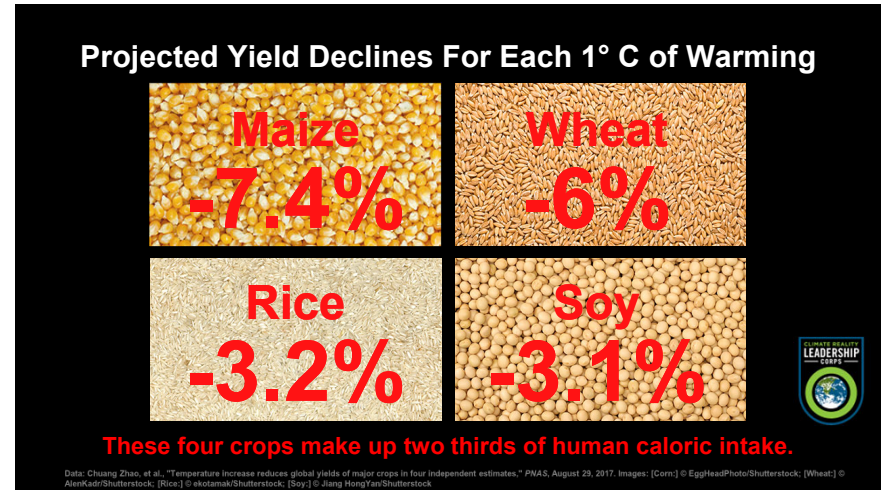
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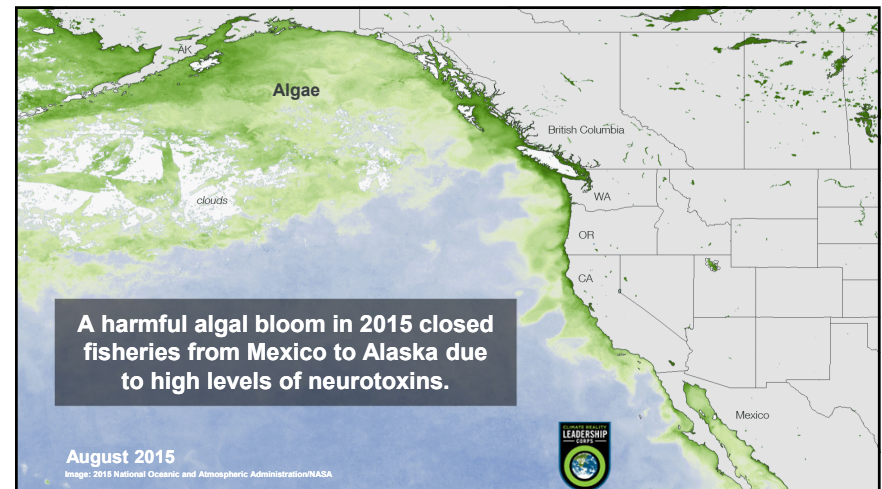
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### Other Climate-Sensitive Challenges

- **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**

microorganisms  
The Threat of Antibiotic Resistance in Changing Climate  
World Economic Forum | June 2019

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**Biology | Aliyar Fouladkhah**

## Changing climate

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

**Part III: Impact Analyses**

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

**research OUTREACH**  
Connecting science with society

**IMPACT ANALYSIS**  
Issue RO 114

**Aliyar Fouladkhah**

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**Twitter @ResOutreach analysis**

The link to your Twitter post: <https://t.co/1b7y1n4rde>

**Demographics**  
 Male 57% Female 40% Unknown 3%

**Device stats**  
 iOS 49% Android 47% Desktop 10%

**Key metrics for all content promoted on Twitter**

Audience	Engagements
42005	8236

**Top interests**

Technology	Biology	Healthcare
56%	53%	48%

**Biology | Aliyar Fouladkhah**

## Changing climate

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

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**Facebook.com/ResearchOutreach**

The link to your Facebook post: <https://fb.com/156176d>

**Demographics**  
 Male 65% Female 35%

**Device stats**  
 iOS 31% Android 37% Desktop 32%

**Key metrics for all content promoted on Facebook**

People reached	Engagements
31317	4564

**Age range**

**Biology | Aliyar Fouladkhah**

## Changing climate

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

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**researchoutreach.org website analysis**

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

**Number of visits for Research Outreach website**

**Demographics**  
 Male 49% Female 51%

**Age range**

**Geographical location of web viewers**

**Browser stats**

**Platform and device stats**

Tablet	Desktop	Mobile
43%	32%	25%

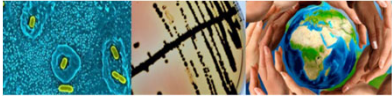

**Biology | Aliyar Fouladkhah**

## Changing climate

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


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## Response of the Government: Food Safety Modernization Act


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### Food Safety Modernization Act (FSMA)

- Signed to law in January of 2011, FSMA is the largest expansion of U.S. food safety authorities since the 1930s.
- Many sectors of agriculture and manufacturing will undergo strict regulations for the **first time in the history of the country**.
- Shifting responses from food safety problems to **proactively prevent** the episodes
- FSMA, a large and comprehensive legislation **broaden FDA's ability** to:
  - Mandatory recall** of contaminated food products
  - Enhanced surveillance** to investigate foodborne illness outbreaks
  - Established **new preventive controls** and food safety plans at some food processing facilities and farms
  - Enhanced FDA's **traceability capacity**
  - Increased inspection** frequencies of high-risk food facilities (both domestic and foreign facilities)
  - Expanded authority and oversight capabilities with regard to **foreign companies**

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Mandated by FSMA	Not mandated by FSMA
<p>PC QI Certifications</p> <ul style="list-style-type: none"> <li>Food manufacturing (processors)</li> <li>Farmers and growers (producers)</li> <li>Transportation, retailers</li> <li>Imported foods</li> <li>Third party laboratories</li> <li>Local, state, and federal agencies</li> <li>Foreign governments</li> </ul> 	<ul style="list-style-type: none"> <li>FSMA does not directly address sectors under <b>pre-existing jurisdictions</b>. HACCP will remain the dominant regulation for:                             <ul style="list-style-type: none"> <li>Meat, poultry, and egg products (USDA-FSIS)</li> <li>Juices, seafood, and shell eggs (DHHA-FDA)</li> </ul> </li> <li>Very small producers and processors could receive exception from FSMA requirements (<b>cottage industry</b>).</li> <li>FSMA does not mandate <b>GM products, antibiotic resistant organisms, organic production, and pesticide and fertilizer</b> use.</li> </ul>

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Thank you!



Dr. Aliyar Cyrus Foadalshah,  
Faculty Director, Public Health Microbiology Laboratory, Associate Professor, Tennessee State University  
Email: [afoadalsh@tnstate.edu](mailto:afoadalsh@tnstate.edu) or [aliyar.foadalshah@ayva.wak.ac.uk](mailto:aliyar.foadalshah@ayva.wak.ac.uk) (do not share without permission)  
Phone: (970) 690-7392  
Website: <https://publichealthmicrobiology.education/>

Contributions of members of the Public Health Microbiology Laboratory is greatly acknowledged. Funding supports of the program leaders are additionally and gratefully acknowledged.



Photos Courtesy: Adobe Stock, royalty purchased (standard) licensed by public health microbiology laboratory.






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# The Assignment



**Additional Information about the Public Health Microbiology Foundation Could be Accessed at:**

**<https://publichealthmicrobiology.education/>**

## FARMER-TO-FARMER VOLUNTEER ASSIGNMENT FORM

*Partners' USAID-funded Farmer-to-Farmer Program (F2F) provides technical assistance to agricultural producers, organizations, agribusinesses, and universities in Latin America and the Caribbean. Through F2F, U.S. specialists spend two to three weeks on specific technical assignments, working directly with counterparts in the region to address local needs.*

### GENERAL INFORMATION

Type of Volunteer Requested: [Food Quality Control Expert] |

Country Project: Flex-Haiti

Best Dates for Volunteer Visit: Virtual, as soon as possible; Physical, March 20<sup>th</sup> – 31<sup>st</sup> 2022 (based on COVID-19).

### PROJECT OVERVIEW

[Ranfòse Abitid Nitrisyon pou fè Ogmante Sante project (RANFOSE) was launched in July 2017 by the Haitian Government to fight micronutrient deficiencies which represent a real public health problem in Haiti. The most recent studies have shown that 22% of children under five are stunted or chronically malnourished, including 8% in its severe form and 4% in acute malnutrition<sup>1</sup>. In addition, 49% of non-pregnant women of child bearing age and 66% of children aged 6 to 59 months are anemic<sup>2</sup> while 34.9% of the Haitian population is exposed to the risk of zinc<sup>3</sup> deficiency. These deficiencies cause a decrease in cognitive development, weaken the immune systems and decrease productivity, among other deleterious effects. To alleviate this situation that the Haitian Government has adopted a law on food fortification. According to this law, all the flour sold on the market must be enriched with iron, folic acid, zinc and vitamin B. At the same time, the salt must be iodized (Potassium Iodate) and the oil enriched with vitamin A. |

### ASSIGNMENT PURPOSE AND EXPECTED RESULTS

To provide training on Food Safety, and quality control, and assist the national food control laboratory in the development of testing protocols for vitamins and minerals in wheat flour, oil and salt. As a result of this assignment it is expected that the national laboratory will have standard operating procedures for testing fortified food products as well as training on equipment being used for the tests. This assignment will be organized as a training workshops (Food Safety Certification) and traditional in-person meetings and assistance to the national lab staff. This assignment contributes to increased food security and a reduction in stunting, namely in Haitian children.

<sup>1</sup>Enquête Morbidité Mortalité et Utilisation des Services, 2016-2017

<sup>2</sup>EMMUS VI

<sup>3</sup>Wessells KR, Brown KH. Estimating the global prevalence of zinc deficiency: results...prevalence of stunting. PLoS One 2012; 7: e50568.

**DESIRED QUALIFICATIONS OF VOLUNTEER**

What skills, background, and professional experience characterize the ideal volunteer for the assignment? Please be specific so that the most appropriate volunteer can be recruited. Please have these in bullet form.

Dr. **Aliyar Fouladkhah**, PhD, MPH, CFS who is the associate Professor at the Department of Agricultural and Environmental Sciences with whom we have already worked and is willing to work with us is a great fit.

- Education: Food Science and Human Nutrition with experience in food safety, quality control and lab test
- Experience: 5 years or more in the field of quality control
- Language: French and English |
- Experience working in a developing country preferred
- Flexibility: flexible to travel to Haiti

**EXPECTED DELIVERABLES**

- Conduct a training session on Food Safety Certification, quality control of food for industries, government entities such as ministry of commerce and industry, ministry of health, ministry of agriculture
- Introduce the laboratory and other entities of the national quality control system
- Present international quality control standards
- Present the material to be used for collecting samples and carrying out tests
- Develop SOPs for carrying out tests for each vitamin and mineral as well as for the other quality control parameters by product.
- Develop surveillance registers for quality control
- Present a frequency of tests with roles and responsibilities for all parties
- Establish data analysis and develop a format for reporting results
- Propose a training guide for the personnel responsible for carrying out the tests
- F2F trip report
- F2F Recommendations Form (to be completed on the final Friday of the assignment)
- One blog post about your F2F activity

**PARTNER ORGANIZATION(S) & HOST ORGANIZATION(S)**

| RANFOSE, National Food Quality Control Laboratory, and Industries in the food fortification sector |

**RESOURCES TO BE CONTRIBUTED BY HOSTS AND LOCAL PARTNERS**

- Coordinate the work in the field and provide technical personnel to accompany the volunteer;
- Provide in-country transportation, office space for meetings, and facilities for training and/or



workshops; and

- Provide supplies, equipment, and other resources for training activities.

### **ASSIGNMENT ITINERARY (GENERAL)**

A more detailed itinerary will be prepared once the volunteer and travel dates are confirmed. After receiving a detailed itinerary, volunteers are encouraged to directly contact host staff to ask specific questions regarding their assignment.

**Accommodations:** F2F host will directly reserve hotels in field and will reimburse volunteer for hotels expenses upon receipt of the F2F trip report.

**Transportation:** F2F host staff will meet the volunteer at the airport or provide prearranged transportation from airport. F2F host will provide all transportation to and from hotels in the field.

**Food:** Volunteers will be provided a per diem to cover meals and incidental expenses. The F2F host will help in identifying places to eat.

### **USAID CLASSIFICATION OF VOLUNTEER ASSISTANCE AND ACTIVITIES**

Primary classification for volunteer assistance (select one)

- Technology Transfer
- Organizational Development
- Business/Enterprise Development
- Financial Services
- Environmental Conservation
- Administrative

Primary classification of the type of value chain activity (select one)

- Information and Input Support Services (extension services, input supplies, veterinary services, etc.)
- On-Farm Production
- Processing (primary and final product transformation, storage, transportation, etc.)
- Marketing (branding, advertising, promotion, distribution, sales, etc.)

### **PERSUAP – Volunteer Assignment Type**



- |                                     |        |   |
|-------------------------------------|--------|---|
| <input type="checkbox"/>            | Type 1 | Volunteers provide direct assistance for the use or procurement of pesticides and are likely to recommend and/or provide advice on specific pesticide active ingredients or products.       |
| <input type="checkbox"/>            | Type 2 | Volunteers provide indirect assistance for the use or procurement of pesticides; they are not expected to recommend or provide advice on specific pesticide active ingredients or products. |
| <input checked="" type="checkbox"/> | Type 3 | Volunteers are not expected to be involved in pesticide issues.   |
| <input type="checkbox"/>            | Type 4 | Volunteers work on a separately-funded USAID project/activity which may have a PERSUAP governing its operations related to the use and procurement of pesticides.                           |

**RECOMMENDED PREPARATION**

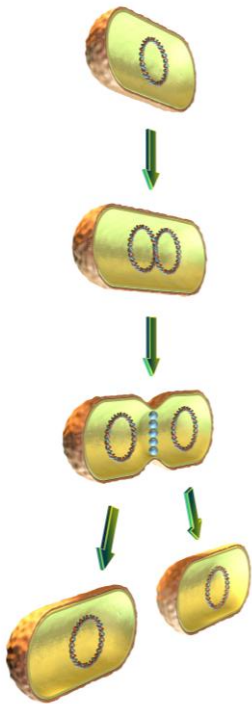
- [Please provide any additional recommendations here for volunteer preparation for this specific assignment]
- Please thoroughly read and follow the instructions provided in the volunteer orientation manual.
- Bring comfortable shoes for walking and a hat for sun protection.
- Bring any videos, posters, PowerPoints, or other materials that are important to your training and activities. We recommend you bring these materials on both a USB flash drive and upload them to cloud storage (ex: Google Drive) as flash drives may be prone to viruses.
- The F2F field office has a projector, flash drives, and other materials that can be used for training and workshops.
- Please advise the field staff if you have any specific dietary restrictions, special medical needs, food allergies, etc.
- When you arrive at the airport, please wear your F2F hat so the host can recognize you.

**Contact Information**

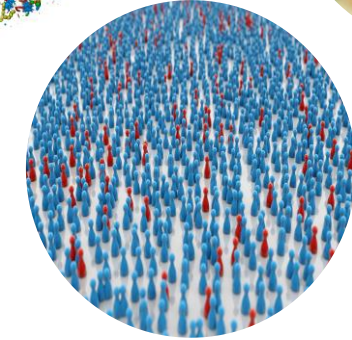
Dr. Ruth Climat, Technical Director RANFOSE [rclimat@partners.net](mailto:rclimat@partners.net) |

# Bacterial Multiplication

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



<u>Time</u>	<u># of Bacteria</u>
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



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

Information and photos are modified and adopted from BBB of Food and Drug Administration, BAM Resources of Centers for Disease Control and Prevention. Photo Courtesy: Adobe Stock (standard 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 BBB of Food and Drug Administration (2<sup>nd</sup> edition).

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





**John Ogonowski and Doug Bereuter Farmer-to-Farmer Program**  
*Volunteer Recommendations Form*

Name of Volunteer: Dr. Aliyar Cyrus Fouladkhah  
Country of Service: Haiti Dates of Trip: March 2022

# of Persons <i>Formally</i> Trained <sup>1</sup> – male:	8	
# of Persons <i>Formally</i> Trained – female:	9	
# of Persons <i>Formally</i> Trained – Non-Binary:		
# of Persons <i>Formally</i> Trained who are Youth:		
# of Persons <i>Formally</i> Trained – total:	17	

**\*\*Please review footnotes for definitions of “persons trained” and “persons directly assisted”\*\***

**Recommendations Made by the Volunteer:<sup>2</sup>**

Please summarize the recommendations you made to the people/groups/organizations you assisted. Details of the recommendations should be included in the trip report – this is a summary table only.

<b>Recommendation</b>	<b>Category*</b>	<b>Host</b>	<b>Time frame to implement change</b>
Incorporating food safety plan and risk assessment discussed in the meeting as part of food manufacturing practices.	1,2, and 3	Recommendation for members of food industry participants.	6 to 12 months
Including the discussed transboundary infectious diseases as part of importation of food products and for tourism by the country’s ministry of health	1,2, and 3	Recommendation for members of the ministry of health participated in the workshop.	6 to 12 months
Incorporating information about climate change on food security and public health for justifying the need for further fortification programs based on information provided in the workshop	1,2, and 3	Recommendation for members of RANFOSE participated in the workshop.	6 to 12 months

\* All recommendations should fall under one of four categories:

1. **Economic:** improvement of profitability of the farm, business, or enterprise
2. **Organizational:** improvement to organizational effectiveness, management, and sustainability
3. **Environmental:** improvement of environmental management and natural resource conservation
4. **Financial:** improvement in the provision of financial services

<sup>1</sup> **Persons Formally Trained:** number of persons who received technical/instructional training in a “formal” setting: classroom, workshop, institute/university or on-the-job setting with specific learning objectives and outcomes

<sup>2</sup> **Recommendations Made by the Volunteer:** The definition of “recommendation” is quite subjective, but might include an improved procedure, a technological or management innovation, a useful product or marketing tool, etc. Volunteers might make numerous detailed recommendations to a variety of hosts. Recommendations should be written in a way that is clear and measurable. *Please try to limit recommendations to no more than six per host.*