



5th Annual  
YALE FOOD SYSTEMS  
SYMPOSIUM

# Assisting Emerging Entrepreneurs and Small Farmers Meeting Requirements of the New Food Safety Regulatory Climate

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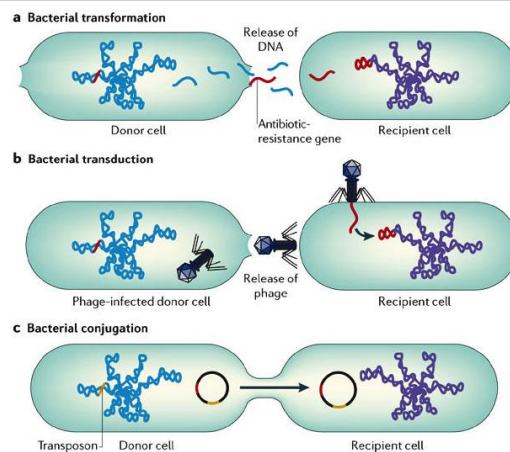
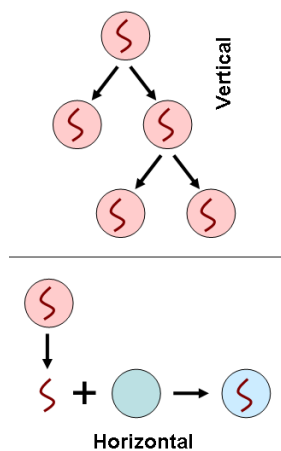
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## Emerging pathogens

Diversity, moving towards "fitness" and Emerging Pathogens



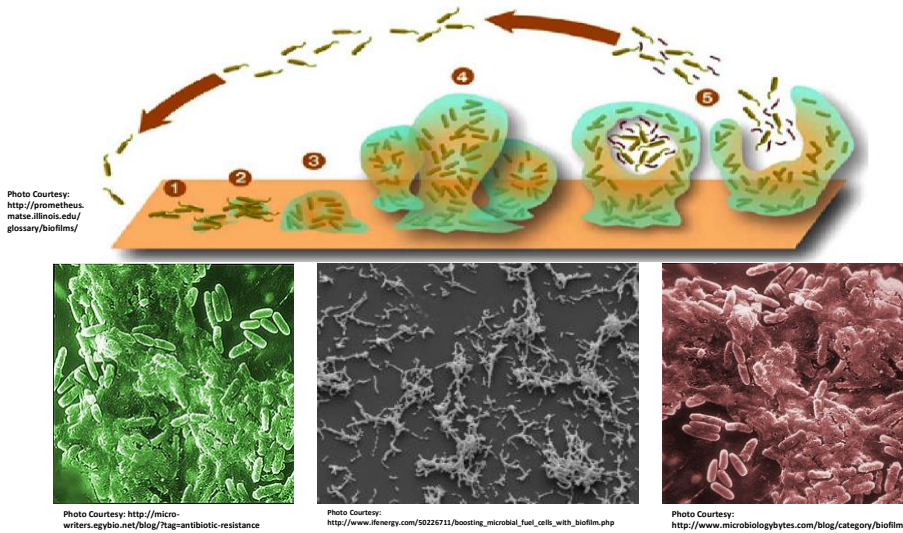
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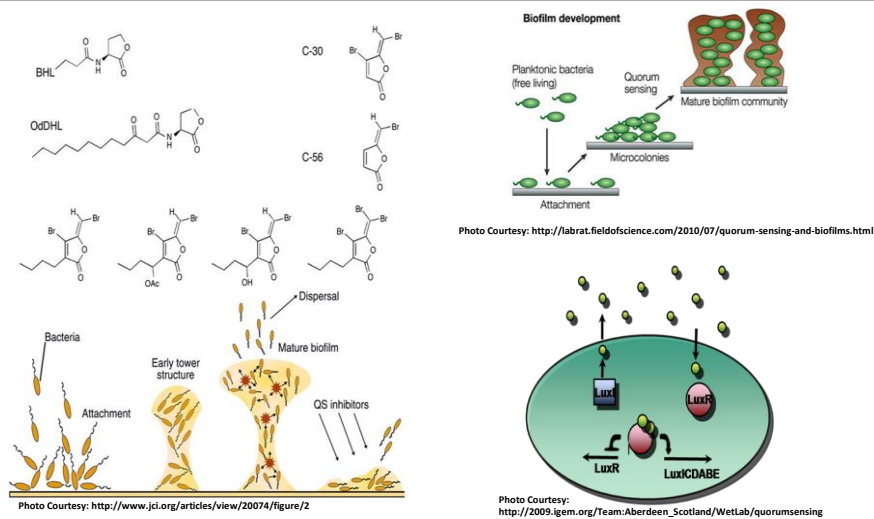
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# Planktonic cells and Biofilm Communities

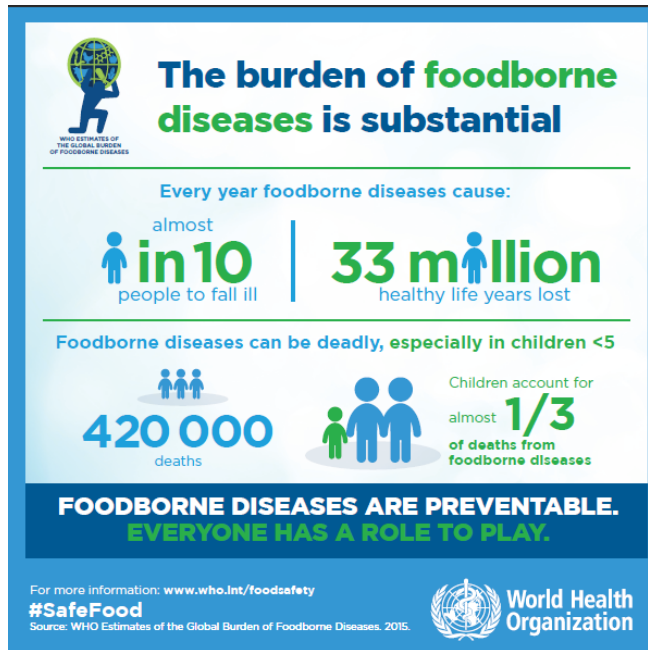


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# Quorum Sensing and Biofilm formation



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## Epidemiology of Foodborne Diseases

- **Based on data from 1990s:** (Mead et al., 1999)  
76 million illnesses, 323,000 hospitalizations, 5,200 deaths in the United States.
- **More recent estimates show:** (Scallan et al., 2011)  
47.8 million illnesses, 127,839 hospitalizations, and more than **3,037** deaths in the United States.
- 9.4 million illnesses, 55,961 hospitalizations, and 1,351 deaths are cause by 31 known foodborne agents.
- In addition to consumer insecurity, foodborne diseases cause around **\$77.7 billion** for losses in productivity and economical losses.
- Approximately 30% of population are especially “at risk” for foodborne diseases (The YOPI’s: The young, the old, Pregnant, and Immunocompromised)

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## Significant foodborne pathogens...

*based on Mead et al., 1999 and Scallan et al., 2011 studies*

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

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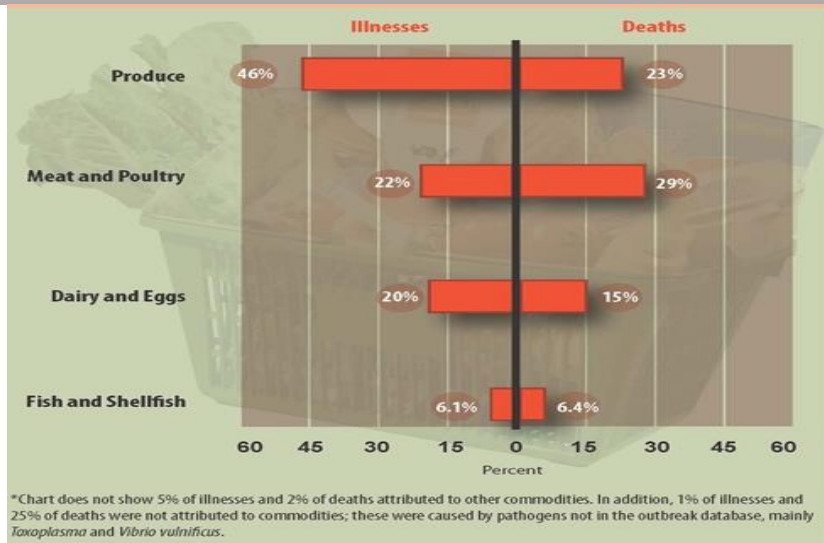
## Significant Foodborne Pathogens of Public Health Concern: Considering DALY and QALY *(Scallan et al., 2015)*

- **Disability Adjusted Life Year (DALY).** *Loss of life and health due to illness compared with 'perfect' health*
- **Quality Adjusted Life Year (QALY)**  
*equates to one year in perfect health*
- Non-typhoidal *Salmonella* (329000)
- *Toxoplasma* (32700)
- *Campylobacter* (22500)
- *Norovirus* (9900)
- *Listeria monocytogenes* (8800)
- *Clostridium perfringens* (4000)
- *Escherichia coli* O157 (1200)
- **62% bacterial agents; 29% parasitic agents; 9% viral agents**
- *Mild illness (no medical care sought)*
- *Guillain–Barré syndrome*
- *Post-infectious irritable bowel syndrome*
- *Reactive arthritis*
- *Haemolytic uraemic syndrome*
- *End-stage renal disease*
- *Death*

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## CDC Estimates of Food Safety Burden

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



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## National-wide and Regional Foodborne Episodes

- Centers for Disease Control and Prevention: Foodborne diseases episodes 1998 to 2016.

	Outbreaks	Illness	Hospitalization (4%)	Deaths (0.1%)
<b>Nation-wide</b>	19,986	387,788	15,562	318
<b>Tennessee</b>	299*	7,212	276	1
<b>TN%</b>	1.5%	1.86%	1.78%	0.31%

\*Etiological agents for episodes:

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

*Fouladkhah et al., 2018 (in review publication); Data source: <http://wwwn.cdc.gov/foodborneoutbreaks/>*

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## National-wide and Regional Foodborne Episodes Involving Poultry

- Centers for Disease Control and Prevention: Foodborne diseases episodes 1998 to 2016.

	Outbreaks	Illness	Hospitalization	Deaths
<b>Nation-wide</b>	1,261	22,868	992	10
<b>Tennessee</b>	19*	338	37	0
<b>TN%</b>	1.51%	1.48%	3.73%	0

\*Etiological agents:

*Salmonella* serovars (5 episodes); *Staphylococcus aureus* (3 episodes); *Campylobacter* (2 episodes); *Clostridium perfringens* (2 episodes); *Bacillus cereus* (2 episodes); *Norovirus* (2 episodes); *Escherichia coli* (1 episode); *Giardia* (1 episode)

Fouladkhah et al., 2018 (in review publication); Data source: <http://wwwn.cdc.gov/foodborneoutbreaks/>

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## National-wide and Regional Foodborne Episodes Involving All Leafy Greens

- Centers for Disease Control and Prevention: Foodborne diseases episodes 1998 to 2016 (Outbreaks involving leafy greens and salads)

	Outbreaks	Illness	Hospitalization	Deaths
<b>Nation-wide</b>	449	11,278	286	3
<b>Tennessee</b>	23*	1,147	27	0
<b>TN%</b>	5.12%	10.17%	9.44%	0

\*Etiological agents:

Norovirus, *campylobacter*, *Salmonella*, *Bacillus cereus*, *Escherichia coli*, and parasites.

Fouladkhah et al., 2018 (in review publication); Data source: <http://wwwn.cdc.gov/foodborneoutbreaks/>

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