

Keys

80 **Key A** Situations that likely contributed to outbreaks of foodborne diseases when meat or poultry were

Meat or Poultry		Farm/Field							Processing					
		Colonized/Infected/Toxigenic Animals	Contamination Issues					Inadequate/Improper Cooling	Contamination Issues					
Animal Feces/Manure	Feed		Sewage	Soil/Grass/Mud	Water	Worker	Cross Contamination		During Cooling	Environment	Improper Cleaning of Equipment	Manipulation /Spread	Worker	
<p> ✗ = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes </p>														
MEAT														
Cooked, Pasteurized, and Other Heat Processes	Bacteria													
	<i>Bacillus anthracis</i>	●				●						▲		
	<i>Clostridium botulinum</i>		●			●								
	<i>Clostridium perfringens</i>	✗	✗	▲		✗	▲			▲	▲	▲	▲	
	<i>Escherichia coli</i> STEC/VTEC	●	●	●		●	●		●	✗		✓	✗	▲
	<i>Listeria monocytogenes</i>	●	●	●		●	●		●	✓		✗	▲	
	<i>Salmonella</i>	●	●	●		●	●		●	✗	▲	✓	✓	▲
	<i>Staphylococcus aureus</i>	●					●			▲		▲		✗
	<i>Yersinia enterocolitica</i>	●	●				●		●	▲		▲	▲	
	Parasite													
	<i>Taenia</i> spp.	●								▲				
	<i>Toxoplasma gondii</i>	●								▲				
	<i>Trichinella spiralis</i>	●								▲				
	Virus													
Hepatitis A virus								●					✗	
Norovirus								●			✓		✗	
Cured/Dried / Fermented/ Smoked	Bacteria													
	<i>Escherichia coli</i> STEC/VTEC	●	●			●				▲		▲	▲	▲
	<i>Salmonella</i>	●	●	●			●		●	✓		▲	✓	▲
	<i>Listeria monocytogenes</i>	●	●	●		●	●		●	✓		✗	▲	
	<i>Staphylococcus aureus</i>	●					●			▲		▲	▲	✓
Retorted	Bacteria													
	<i>Clostridium botulinum</i>		●			●				✓				
	<i>Staphylococcus aureus</i>	●						●					✗	
POULTRY														
Retorted	Bacteria													
	<i>Clostridium botulinum</i>		●			●				✓				
	<i>Campylobacter jejuni</i>	●	●			●			✗	✗		▲		
	<i>Clostridium perfringens</i>	✗	✗	▲		✗	▲		▲	▲	▲	▲	▲	
	<i>Listeria monocytogenes</i>	●	●	●		●	●		●	✓		✗	▲	
	<i>Staphylococcus aureus</i>	●					●			▲		▲	✗	
Cured/ Smoked/ Dried	<i>Staphylococcus aureus</i>	●						●	▲			▲	▲	✓

82 **Key B** Situations that likely contributed to outbreaks of foodborne diseases when eggs, milk, or milk

Eggs or Dairy		Farm/Field							Processing				
		Colonized/Infected/ Toxicogenic Animals	Contamination Issues					Inadequate/Improper Cooling	Contamination Issues				
Animal Feces/Manure	Feed		Soil/Grass/Mud	Water	Worker	Cross Contamination	During Cooling		Environment	Improper Cleaning of Equipment	Manipulation/Spread	Worker	
<p> ✖ = Principal Factor to Consider ✔ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes C = Cooling Water Source of Contamination </p>													
EGGS													
Raw or Heated	Bacteria												
Lightly	<i>Salmonella</i>	✖	✖	✖		✔		▲	▲		✔		
	<i>Salmonella</i>	●	●	●		●		▲	▲		▲	▲	
Heated	<i>Staphylococcus aureus</i>	●				●						▲	
	<i>Streptococcus pyogenes</i>	●										✖	
Dried	<i>Salmonella</i>	●	●	●		●		▲	✖		✔	✖	
MILK / MILK PRODUCTS													
Raw	Bacteria												
	<i>Brucella</i>	✖	✖					✔			▲	▲	
	<i>Campylobacter jejuni</i>	✖	✖					✔					
	<i>Escherichia coli</i> STEC/VTEC	✖	✖	✖		✖		✔			▲	▲	
	<i>Listeria monocytogenes</i>	✖	✖		✖			▲		▲	▲		
	<i>Mycobacterium bovis/tuberculosis</i>	✖						✔					
	<i>Salmonella</i>	✖	✖	✖		✖		✔			▲	▲	
	<i>Staphylococcus aureus</i>	✖					✖	✔			▲	▲	
Cooked, Pasteurized, and Other Heat Processes	<i>Streptococcus pyogenes</i>	✖				✖						✖	
	<i>Yersinia enterocolitica</i>	✖	✖			✖		✔					
	<i>Escherichia coli</i> STEC/VTEC	●	●			●		✔	▲	▲		▲	
	<i>Listeria monocytogenes</i>	●	●		●			✔	✔	▲	✖	✔	
	<i>Salmonella</i>	●	●	●		●		✔	✔	▲		✔	
Dried	<i>Staphylococcus aureus</i>	●				●		✔	▲	▲		✔	
	<i>Yersinia enterocolitica</i>	●	●			●		✔	▲	▲		✔	
	<i>Salmonella</i>	●	●	●				✔	✖		✖	✔	
	<i>Staphylococcus aureus</i>	●				●		✔			▲	▲	
CHEESE													
Fermented	Bacteria												
	<i>Brucella</i>	●						✔					
	<i>Clostridium botulinum</i>	●	●		●								
	<i>Escherichia coli</i> O157:H7	●	●	●			●	✔	▲				
	<i>Listeria monocytogenes</i>	●	●		●			✔	✔		✖	✔	
	<i>Salmonella</i>	●	●	●		●		✔	✔				
	<i>Staphylococcus aureus</i>	●				●		✔				✖	
Toxin													
	Histamine												
BUTTER													
Whipped	Bacteria												
	<i>Staphylococcus aureus</i>	●					●	✖				✖	
	<i>Listeria monocytogenes</i>	●	●		●				✖	✖	✔		
ICE CREAM													
Frozen	Bacteria												
	<i>Salmonella</i>	●	●	●		●		✔	▲				
	<i>Salmonella</i> Typhi						●	✔				✖	
	<i>Staphylococcus aureus</i>	●					●	✔				✖	

84 **Key C** Situations that likely contributed to outbreaks of foodborne diseases when fish, shellfish,

Fish/ Seafood	Farm/Field										Processing																			
	Colonized/Infected/ Toxicogenic Animals	Environment/ Climate	Contamination Issues							Contamination Issues																				
			Feed	Sewage	Soil/Grass/Mud	Storage	Water	Worker	Inadequate/Improper Cooling	Prolonged Storage	Cross Contamination	Environment	Improper Cleaning of Equipment	Manipulation/Spread	Use of Contaminated Water	Worker														
✗ = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes																														
FISH																														
Raw	Bacteria																													
	<i>Salmonella</i>			▲	▲		▲	▲	▲	▲			✓	✓	✓	✓			▲											
	Parasite																													
	Various (such as <i>Anisakis/Pseudoterranova, Diphyllobothrium latum</i> (fish tapeworm))	✗	▲																											
Retorted	Bacteria																													
	<i>Clostridium botulinum</i>	●	●			●																								
	Toxin																													
	Histamine											✗																		
Heated	Bacteria																													
	<i>Salmonella</i>			●	●	●	●	●	●	●		✓	▲	▲	▲	▲			▲											
	<i>Vibrio cholerae</i> (O1/non O1)		●		●		●	●	●			▲	▲	▲	▲	▲	▲		▲											
	<i>Vibrio parahaemolyticus</i>		●				●		●			▲	▲	▲	▲															
	Toxin																													
		Ciguatoxin	✗	✓																										
	Histamine										✗																			
Smoked	Bacteria																													
	<i>Clostridium botulinum</i>	●	●			●																								
	<i>Listeria monocytogenes</i>		●			●		●				✗	✗	✗	▲															
	<i>Salmonella</i>			●		●	●	●	●			✓	▲	▲	▲				▲											
	<i>Staphylococcus aureus</i>								●			▲							✗											
Dried	Bacteria																													
	<i>Salmonella</i>				●	●	●	●	●			✓	✓	▲	▲				▲											
	<i>Staphylococcus aureus</i>							●				▲							✗											
Salted	Bacteria																													
	<i>Clostridium botulinum</i>	●	●			●																								
	<i>Listeria monocytogenes</i>		●			●		●				✗	✗	✗	▲															
	<i>Staphylococcus aureus</i>							●			▲								✗											
Fermented	<i>Clostridium botulinum</i>																													
		●	●			●																								
MOLLUSCS (Clams, Oysters, Mussels)																														
Raw	Bacteria																													
	<i>Salmonella</i>	✗	✗		▲		▲		▲	✓		▲	▲	▲																
	<i>Salmonella</i> Typhi	✗	✗	✗					✗	✓									✗											
	<i>Vibrio cholerae</i> O1	✗	✗	✗				✗	✓	✓		▲							✓											
	<i>Vibrio cholerae</i> non-O1	✗	✗					✗		✗		✓		▲																
	<i>Vibrio parahaemolyticus</i>	✗	✗					✗		✗		✓		▲																
	<i>Vibrio vulnificus</i>	✗	✗					✗		✓																				
	Toxin																													
		Azspiracids	✗	✓																										
		Diarrhetic shellfish poison	✗	✓																										
		Domoic acid	✗	✓																										
		Paralytic shellfish poison	✗	✓																										
	Virus																													
		Hepatitis A virus				✗				✓										✓										
		Norovirus				✗				✓			✓							✓										

88 **Key D** Situations that likely contributed to outbreaks of foodborne diseases when vegetables were

Vegetables	Farm/Field							Processing						
	Colonized/Infected/ Toxicogenic Animals	Environment/Climate	Contamination Issues				Prolonged Storage	Contamination Issues						
Animal Feces/ Manure			Sewage	Soil/Grass/Mud	Water	Worker		Cross Contamination	During Cooling	Environment	Improper Cleaning of Equipment	Manipulation/Spread	Use of Contaminated Water	Worker
✗ = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of Contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes														
HERBS/ GREEN ONIONS/PEPPERS (hot and mild)														
Raw / Dried	Bacteria													
	<i>Escherichia coli</i> O157:H7	✗	✓	✗		▲	✗		✓	✓	✓		▲	
	<i>Salmonella</i>	✗	✗	✓	✓	▲	✗		✓	✓	✓			
	<i>Shigella</i>				✓		✓	✗					✓	✗
	Parasite													
	<i>Cyclospora cayetanensis</i>				✗		✗	✗						✗
	Virus													
	Hepatitis A Virus				✓		✗	✗						✗
LEAFY GREENS														
Raw	Bacteria													
	<i>Escherichia coli</i> STEC/VTEC	✗	✗	✗		✓	✗		✓	✓	▲		▲	
	<i>Listeria monocytogenes</i>	✗		✗		✗		✗			✓		▲	
	<i>Salmonella</i>	✗	✗	✗	▲	✓			✓	✓	▲		▲	
	<i>Shigella</i>				✗	✓	✗						▲	✗
	Parasite													
	Various (such as <i>Cryptosporidium</i> and <i>Giardia</i>)	✗		✗		✗	▲	✓	✓		✓		✓	✓
	Virus													
	Hepatitis A Virus				✗	✓	✗						▲	✗
	Norovirus				✗	✓	✗		✓				▲	✗
POTATOES														
Heated	Bacteria													
	<i>Clostridium botulinum</i>				●		●							
SPROUTS														
Raw	Bacteria													
	<i>Escherichia coli</i> O157:H7	✗	✓	✗		✓	▲		✓	✓	▲	✓	▲	
	<i>Listeria monocytogenes</i>					▲	▲		✗	✗	✓	✓		
	<i>Salmonella</i>	✗		✗	▲	✓	▲		✓	✓	▲	✓	▲	
TOMATOES														
Raw	Bacteria													
	<i>Salmonella</i>	✗	✗	✓			✗		✓	✓	✓	▲	✓	▲
	<i>Shigella</i>				▲		✓							✗
VEGETABLES (all)														
Raw	Bacteria													
	<i>Escherichia coli</i> O157:H7	✗	✗	✓		▲	✓		✓	✓	▲	▲	▲	
	<i>Salmonella</i>	✗	✗	✓		▲	✓		✓	✓	▲	▲	▲	✗
	<i>Shigella</i>				✓	✓	✗						✓	▲
	<i>Yersinia pseudotuberculosis</i>	✗						✗	✓		✓			
	Parasite													
	<i>Cyclospora cayetanensis</i>				▲		✗	✗					✓	✗
	Virus													
	Norovirus				✓	✓	✓		✓				✓	✓
Retorted	Bacteria													
	<i>Clostridium botulinum</i>				●		●			▲			✓	
	<i>Staphylococcus aureus</i>							●						✗
Heated	<i>Bacillus cereus</i>					✗								
BEANS/LEGUMES														
Heated / Refried	Bacteria													
	<i>Bacillus cereus</i>					✗								
	<i>Clostridium perfringens</i>				▲	▲	✗				▲		▲	

										Retail Store/Food Service/Home												
Holding/Storage					Processing					Contamination		Holding/Storage			Processing							
Improper Hot Holding	Inadequate Refrigeration	Prolonged storage	Room/Outdoor Temperature Holding	Heat Process Failure	Improper Cooling	Improper pH Adjustment	Improper Water Activity (a _w)	Inadequate Reheating	Organism/Toxin Survives Process	Improper/Defective Packaging	Cross Contamination	Improper Cleaning of Equipment	Worker/Person	Improper Hot Holding	Inadequate Refrigeration	Prolonged storage	Room/Outdoor Temperature Holding	Heat Process Failure	Improper Cooling	Inadequate Reheating	Organism/Toxin Survives Process	
	✓										✓	✓			✓		▲					
											✓	✓			✓	✓	✓					
	✗										▲		✓		✓		▲					
													✗									
													✗									
													✗									
	✓										✓	▲			✓							
	✓	✗									▲	▲			✓	✓						
	✓										▲	▲	✗		▲		▲					
											✓	✓	✓									
													✗									
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												▲		✗	✓		✗		✓		✓	
			✓					✓							✓	✓						▲
	✓								✓						▲	▲	▲					
		✓						✓						▲	▲	▲						
											✓		▲	✓		✓						
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	✓										✓			✓		✓						
	✓										✓		✗	✓	✓	✓						
		✗	✗										✗	✓	✓	✓						
											✓		✗									
				✗		✓	▲		✗	✗								✗				✗
	✗	✗			✓		T					▲		✗	✗	✓	▲		▲		T	✓
				✓					✗		▲	▲		✗	✗	✓	✗		✗	T	✓	
			✓		✗				✗		▲	▲		✗	✗	✓	✗		✗	✗	✗	
			✓		✗				✗		▲	▲		✗	✗	✓	✗		✗	✗	✗	

Fruits, Nuts, Spices, Grains, or Mushrooms	Farm/Field										Processing					
	Colonized/Infected/Toxicogenic Animals	Contamination Issues								Inadequate/Improper Cooling	Storage Conditions	Contamination Issues				
		Animals Access Human	Sewage	Animal Feces/Manure	Feed	Sewage	Soil/Grass/Mud	Storage	Water			Worker	Storage Contamination	During Cooling	Environment	Improper Cleaning of Equipment
× = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes																
NUT/NUT BUTTERS, e.g., Peanuts, Almonds, Pistachios																
Raw	Bacteria															
	<i>Salmonella</i>	×		×		✓		▲	▲			✓	✓	✓	✓	▲
Processed	Bacteria															
	<i>Salmonella</i>	●		●		●		●	●			×	×	×	✓	▲
Retorted	Bacteria															
	<i>Clostridium botulinum</i>					●										
COCONUT																
Dried	Bacteria															
	<i>Salmonella</i>	×		×	▲	✓		▲	▲			×	✓	▲	▲	▲
SPICES																
Dried/ Fermented	Bacteria															
	<i>Salmonella</i>	×		×	▲	✓		▲	▲			×	✓	✓	▲	▲
GRAINS/RICE (Flour)																
Raw	Bacteria															
	<i>Escherichia coli</i> STEC/VTEC	×		×		✓							▲	✓		
	<i>Salmonella</i>	×		×	▲	✓		▲	▲			✓	✓			
	Toxins															
Aflatoxin					×						×				▲	
Heated	Bacteria															
	<i>Bacillus cereus</i>					×										
BREADS/PASTRIES/DONUTS																
Processed	Bacteria															
	<i>Salmonella</i>											✓				×
	Virus															
	Norovirus											✓	✓			
Hepatitis A Virus																×
PASTA/NOODLE																
Processed	Bacteria															
	<i>Staphylococcus aureus</i>								●					✓		×
with eggs	<i>Salmonella</i>	●		●		●						▲		▲		▲
MUSHROOMS																
Raw	Bacteria															
	<i>Salmonella</i>	×		×	▲	×			▲							▲
Retorted	Bacteria															
	<i>Clostridium botulinum</i>					●							▲			
<i>Staphylococcus aureus</i>								●	●							×

Mixed foods		Farm/Field					Processing						
		Colonized/Infected/ Toxicogenic Animals	Environment/ Climate	Contamination			Contamination Issues						
Animal Feces/Manure	Soil/ Grass/Mud			Worker	Cross contamination	During Cooling	Environment	Improper Cleaning of Equipment	Manipulation/ Spread	Use of Contaminated Water	Worker		
✗ = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes													
CHOCOLATE													
Formulated/ Blended	Bacteria <i>Salmonella</i>	●	●	●		●	▲		▲	▲	▲	✗	▲
CUSTARD / CREAM-FILLED PASTRY													
Formulated; Formulated/ Heated	Bacteria <i>Salmonella</i> <i>Staphylococcus aureus</i>						✓		▲	▲			▲
							▲			▲			✗
FROSTING / TOPPING													
Formulated/ Blended	Virus Hepatitis A Virus Norovirus												✗
							▲	✓					✗
SOUPS / STEW/ GRAVY													
Formulated/ Heated	Bacteria <i>Bacillus cereus</i> <i>Clostridium perfringens</i> <i>Salmonella</i> <i>Staphylococcus aureus</i>									▲			
										▲			▲
							▲			▲			▲
										▲			✗
RICE-BASED DISHES (Fried rice)													
Mixed/ Heated	Bacteria <i>Bacillus cereus</i>					✗							
MEAT, VEGETABLE/ CEREAL MIXTURES, e.g., Stir fry, Lasagna, Chinese food, Casseroles													
Mixed/ Heated	Bacteria <i>Clostridium perfringens</i> <i>Salmonella</i> <i>Staphylococcus aureus</i>						▲			▲			▲
							▲			▲			▲
							▲			▲			✗
GREEN SALADS WITH PROTEIN, i.e., Vegetable salad with additional processed products, such as													
Mixed/Raw with Portions Heated	Bacteria <i>Campylobacter</i> <i>Escherichia coli</i> STEC VTEC <i>Salmonella</i> <i>Shigella</i>						▲						
							✓	✓	✓	✓	▲		
							✓	✓	✓	✓	▲	▲	
							▲				✓		✗
	Parasite Various (such as <i>Cryptosporidium</i> and <i>Giardia</i>)										✓		✓
	Virus Hepatitis A Virus Norovirus											✓	✗
								▲	✓			✓	✗

														Retail Store/Food Service/Home													
Holding/Storage				Processing				Contamination			Holding/Storage				Processing												
Improper Hot Holding	Inadequate Refrigeration	Prolonged storage	Room/Outdoor Temperature Holding	Heat Process Failure	Improper Cooling	Improper Water Activity (a _w)	Inadequate Reheating	Organism/Toxin Survives Process	Cross contamination	Improper Cleaning of Equipment	Worker/Person	Improper Hot Holding	Inadequate Refrigeration	Prolonged storage	Room/Outdoor Temperature Holding	Heat Process Failure	Improper Cooling	Inadequate Reheating	Organism/Toxin Survives Process								
				X		▲		X	▲	▲	▲																
	X		X	X	X	▲		▲	✓	▲	▲	✓	X		X	X	✓		▲								
	X		X	X	X	✓		T	▲	▲	X	✓	X		X	X	✓		T								
											X																
									▲		X																
X	X		X		X		X	T	X		▲		X	X		X		X	T	X							
X	X		X		X		X	X		▲	▲	X	X		X		X	X	X								
✓	✓		✓	X	✓		✓		▲	▲	▲	✓	✓		✓	X	✓	✓									
X	X		X	▲	▲		✓	T		▲	X	X	X		X	▲	✓	✓	T								
▲	▲		▲		▲		T	✓	▲			X	X		X		X	T	✓	X							
✓	✓		✓		✓		✓	✓	▲	▲	▲	X	X		X		X	X	✓								
✓	✓		✓	✓	✓		✓		▲	▲	▲	X	X		X	X	▲	X									
✓	✓		✓	▲	▲		T	✓	▲	▲	X	X	X		X		✓	T	✓								
Cobb salad, Taco salad, Salads with meat, fish, dairy or egg ingredients																											
	▲		▲	▲	▲				X			▲		▲	✓	▲											
	✓		✓	✓	▲				X	▲		✓		✓	X	✓											
	✓		✓	✓	▲				X	▲	▲	✓		✓	X	✓											
	▲		▲						▲		X	▲		▲													
											✓																
									▲		X																
									▲		X																

(continued)

Mixed foods		Farm/Field					Processing					
		Colonized/Infected/ Toxicogenic Animals	Environment/ Climate	Contamination			Contamination Issues					
Animal Feeces/Manure	Soil/Grass/Mud			Worker	Cross contamination	During Cooling	Environment	Improper Cleaning of Equipment	Manipulation/Spread	Use of Contaminated Water	Worker	
<p>✗ = Principal Factor to Consider ✓ = Factor to Consider ▲ = Potential Factor to Consider ● = Source of contamination, but likely to be destroyed during later processing T = Toxin Survives Heat Processes</p>												
MIXED SALADS, i.e., Mixes of proteins, grains and/or vegetables with most ingredients cooked,												
Some Heated Ingredients	Bacteria											
	<i>Campylobacter</i>								▲			
	<i>Escherichia coli</i> STEC\ VTEC						✓		✓	✓	✓	
	<i>Salmonella</i>						✗		✓	✓	✓	▲
	<i>Shigella</i>											✗
	<i>Staphylococcus aureus</i>						▲			▲		✗
	Virus											
	Hepatitis A Virus											✗
Norovirus						▲		✓			✗	
VEGETABLE SALADS WITH ONLY RAW INGREDIENTS, e.g., Coleslaw, Garden salad, Caesar												
Mixed / Raw With Portions Heated	Bacteria											
	<i>Escherichia coli</i> STEC\ VTEC						✓		✓	✓	✓	▲
	<i>Salmonella</i>						✓	▲	✓	✓	✓	✓
	<i>Shigella</i>						▲				✓	✗
	Parasite											
	Various (such as <i>Cryptosporidium</i> and <i>Giardia</i>)										✓	✓
	Virus											
	Hepatitis A Virus										✓	✗
Norovirus						▲		✓		✓	✗	
COOKIE DOUGH/CAKE BATTER												
Raw	Bacteria											
	<i>Salmonella</i>	✗		✓	✓							
	<i>Escherichia coli</i> O157:H7	✗		✓	✓							

