SureFast® Microbiology – qualitative detection of common foodborne pathogens with qPCR

- **Simple and straightforward** – 10 min lysis protocol
- **Flexible** – open platform
- **Increased efficiency** – multiplex kits

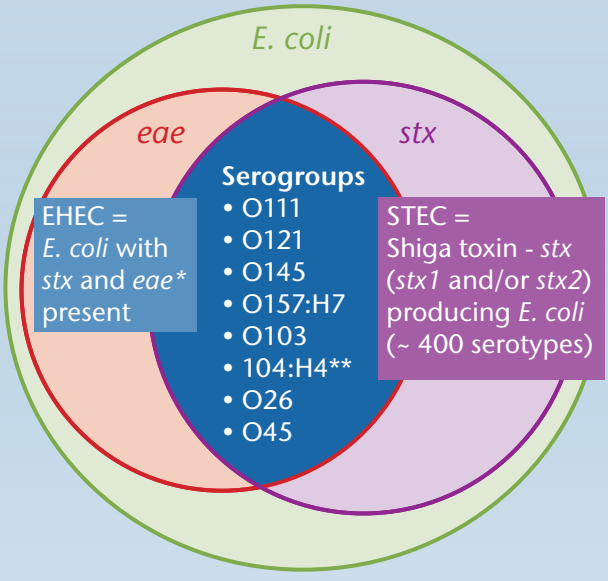
Causes of food poisoning

Various disease-causing organisms can contaminate foods – more than 250 foodborne diseases have been identified. Most of them are infections, caused by a diversity of bacteria, viruses and parasites. But also harmful toxins and chemicals can contaminate foods and cause foodborne illness[1].

The pathogens can be categorized into three groups[2]:

- **Infectious invasive pathogens**
  - Enter the body and invade or colonize host
  - Typically > 8 hr for onset of illness
  - E.g. *Salmonella, Listeria monocytogenes, Campylobacter* and enteroinvasive *Escherichia coli*
- **Toxigenic pathogens:**
  - Produce enterotoxins in the food
  - Illness is not depending on the organism traveling to the intestinal tract implanting and growing
  - Onset of illness can be as little as 1 hr, as the toxin is pre-formed in the food and consumed
  - E.g. *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium botulinum*
- **Toxico-infectious pathogens:**
  - E.g. enterotoxigenic and enterohemorrhagic *E. coli* and *Clostridium perfringens*

What makes an *E. coli* an EHEC?



Adapted from: Byron J. , Understanding STEC: a growing concern, FoodSafety magazine, April/May 2012

Commission Regulation (EC) No. 2073/2005 on microbiological criteria for foodstuffs

This regulation sets harmonized microbiological criteria and how to perform the tests for certain microorganisms. The following pathogens are for example included:

- *Salmonella*
- *Listeria monocytogenes*
- *E. coli*
- *Enterobacter sakazakii*
- *Enterobacteriaceae*
- *Staphylococcal enterotoxins*

Moreover, it provides rules to be obeyed by food business operators when implementing general and specific hygiene measures referred to in (EC) No. 852/2004. Basically, two different types of criteria are established in Regulation 2073/2005:

- Food safety criteria: assess safety of a product/ batch of foodstuff
- Process hygiene criteria: ensure production processes are operating properly

The main difference between them is the consequence: when a food safety criterion is not fulfilled, the batch of the affected food should be recalled or not placed on the market.

The food business operators have thus to ensure that foodstuffs comply with the relevant microbiological criteria at each stage of food production, processing and distribution, including retail, as well as throughout the shelf-life of the products. The criteria comprise absence in a specified amount of the product (generally 25 gram or ml/10 gram or ml) depending on the food stuff and microorganism tested.

* Sometimes referred to as intimin; facilitates adhesion of the bacterium within the human digestive system.

** Genetically, the strain is an enteroaggregative *E. coli* (EAEC).

What are the 'Big Six'?

Foodborne pathogens

The most contagious, causing the most severe symptoms:

- *Escherichia coli*
- Hepatitis A
- nontyphoidal *Salmonella*
- Norovirus
- *Shigella*
- *Salmonella Typhi*

E. coli

Additionally to *E. coli* O157:H7, other *E. coli* serotypes have been shown to produce Shiga toxins and cause foodborne illness. The most commonly serovars are known as the 'big six':

- O26
- O45
- O103
- O111
- O121
- O145

Salmonella

According to Regulation (EC) No. 1086/2011 compliance with 'absence in 25 grams' is mandatory for *Salmonella* Enteritidis and *Salmonella* Typhimurium (including monophasic *Salmonella* Typhimurium strains) in batches of fresh poultry meat, which is meat from fowl breeding hens, laying hens, broilers, turkey breeding hens and fattening turkeys.

STEC

The only existing microbiological criterion for STEC in a food product is defined in the Regulation (EC) No. 209/2013 amending Regulation (EC) No. 2073/2005. This food safety criterion applies to sprouts and the results must be compliant with 'absence in 25 g of STEC O157, O26, O111, O103, O145 and O104:H4, for sprouts placed on the market during their shelf life.'

Campylobacter

Regulation (EC) No. 2017/14956 amending Regulation (EC) No. 2073/2005 describes a process hygiene criterion, relevant for food business operators, aiming to keep *Campylobacter* in broiler carcasses under control and to reduce the number of human campylobacteriosis cases attributable to the consumption of poultry meat. Limit of < 1,000 CFU/g applies (becomes mandatory from 2020 onwards).

Detecting food pathogens using qPCR

Detecting and isolating food pathogens from food-stuff using traditional methods is often labor intense and time consuming (from 5-14) days. Screening enriched samples using qPCR allows a release of negative samples in a short time (~24 h).

Necessary ISO standards and requirements for labo-ratories as well as general requirements for food testing using qPCR based methods are listed in the table below.

ISO	Title
Microbiology of food and animal feeding stuffs – Polymerase chain reaction (PCR) for the detection of food-borne pathogens	
22174:2005-05	General requirements and definitions
20837:2006-08	Requirements for sample preparation for qualitative detection
20838:2006-08	Requirements for amplification and detection for qualitative methods
22118:2011-11	Performance characteristics of molecular detection methods
22119:2011	Real-Time PCR – general requirements and definitions

Validation of ISO alternative methods

For the microbiology of the food chain, several harmonized (EN ISO) standard reference methods exist, which are important tools for the internationally uniform analysis of foodstuffs. The majority of the microbiological EN ISO methods concern 'traditional' culture methods, which are considered as the reference methods. These methods use selective liquid or solid culture media, to grow, isolate, and enumerate the target microorganism and simultaneously prevent the growth of other microorganisms present in the food [3] (Figure 1). Any new/alternative method has to be validated against the reference method, in order to test whether this new method performs at least equally well as the reference method (EN ISO 16140-2) [4] (Figure 2). EN-ISO 16140-2 specifies the general principle and the technical protocol for the validation of alternative methods for microbiology in the food chain. Alternative methods must be therefore:

- Validated against the reference method, and if a commercial kit, certified by a third party using an internationally accepted protocol, i.e. ISO 16140-2 or a similar protocol or
- Validated by an internationally accepted protocol and authorized by the Competent Authority (Figure 1)

	Reference method	Alternative method
Europe	ISO	Alternative methods must be validated according to ISO 16140-2 and certified e.g. third party validation by AFNOR, MicroVal or NordVAL
US	FDA BAM & USDA MLG	Alternative methods must be validated by AOAC
		Must fulfill: • Same result • Ease of use • Time to result • Preferably more sensitive/specific

Figure 1: Reference versus alternative method

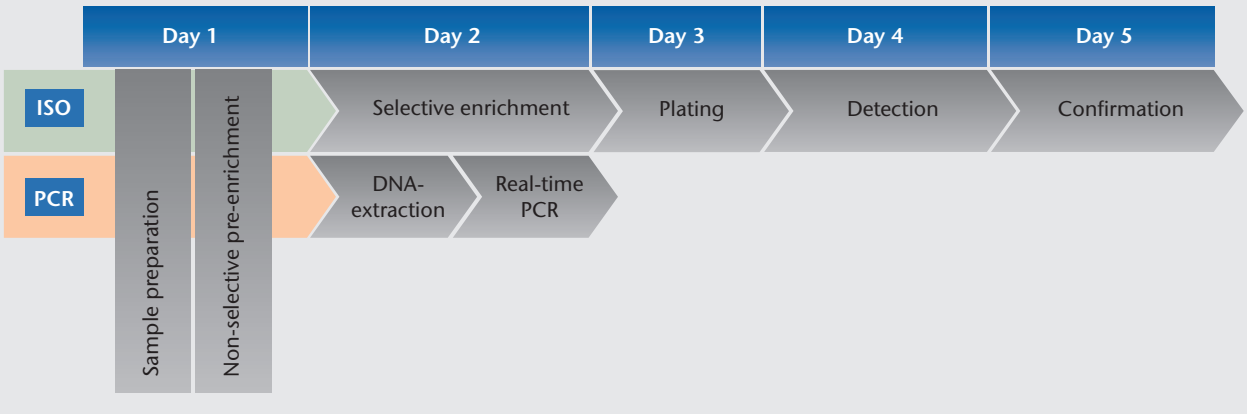


Figure 2: Schematic overview of the time necessary for classical approach according to ISO (around 5 days) and alternative qPCR method (2 days) for detection of pathogens

Exemplary laboratory work flow of a typical real-time PCR pathogen detection assay

Time requirement: 16 - 24 hrs

1 Sample enrichment

- 25 g of sample added to 225 ml of enrichment broth
- Overnight incubation

Time requirement: 0.5 - 1 hrs

2 DNA extraction – see table „Available DNA extraction kits“

- Thermal lysis
- Eventually DNA purification step

Time requirement: ~ 20 min

3 Real-time PCR set-up

- Prepare master mix
- Add extracted DNA

Time requirement: ~ 1 hr

4 Real-time PCR analysis

All SureFast® kits can be used with common real-time PCR devices (FAM/HEX/ROX/Cy5).

A list with more details can be provided on request.

Available DNA extraction kits

DNA extraction kit	Pathogen type	Description	Steps	Hands on time/ 10 samples
SureFast® Speed PREP (F1054)*	GRAM-negative bacteria & parasites	Fast & easy DNA isolation without purification	2	~ 20 min
SureFast® PREP Bacteria (F1021)	Bacteria	Complex matrices with strong inhibitors	7	~ 45 min
SureFast® PREP DNA/RNA Virus (F1051)	Viruses	Cell culture supernatants, foods (e.g. wash up fluids from fruits, salads etc.), filters from water samples	7	~ 45 min
SureFast® Mag PREP Pathogen	Viruses & bacteria	Automated nucleic acid preparation in combination with TANBead Maelstrom™ 8 Autostage (ZMAL8) or Maelstrom™ 4800 (ZMAL48)	Walk away solution	~ 5 min

* Same protocol as the „ONE“ kits.

Possible food contamination sources

At the farm/ production site

- **Animal feed** can be contaminated with bacteria causing infections in animals & potentially lead to human infection from derived food products
- **Fruits and vegetables** can be contaminated before harvest when being irrigated with contaminated water
- **Milk** can be contaminated through contact with e.g. feces or environmental dust
- **Animal skin or fur** can become contaminated by feces

Slaughter

Meat can be contaminated by coming into contact with intestinal contents, animal skin or feces

Further processing

- Microorganisms present in another raw agricultural product or on food contact surfaces may contaminate food
- Contaminated water or ice used for washing, packing, or chilling e.g. fruits or vegetables, the contamination can spread to those produce
- Infected humans handling food may contaminate food
- Contaminated surfaces used for food processing, such as a processing line or storage bins

Distribution

- Leaving refrigerated food on a loading dock for long time in warm weather, may allow bacterial growth due to raising temperatures
- Fresh products can be contaminated by loading them into a truck that was not cleaned (properly) after transporting animals or animal products

Preparation & consumption

- Microbes can be transferred from one food to another by improper use of kitchen utensils or by infected humans handling the food
- Contamination can occur in a refrigerator, if e.g. meat juices get on items that will be eaten raw

Source: [1] and [5]

Reason

Missing proper inspection procedure

Various possible origins of contamination:
- Equipment
- Handling
- Working environment
- Poor temperature control

Effect

- Increased risk that microbiological contaminated produce/ foodstuff may not be detected
- Increasing risk of food spoilage and growth of food pathogens

Distribution of serious food safety hazards

Legislation

The Microbiological Criteria Regulation (EC) 2073/2005

- Food safety criteria: assess safety of a product / batch of foodstuff
- Process hygiene criteria: ensure production processes are operating properly

Possible consequence

If the Food Safety Criteria are not met, the product is reckoned as 'unsatisfactory'

Under 178/2002/EC there is then an obligation on the brand owner to

- Withdraw unsafe food from the market
- Notify the Competent Authority
- Further action may include product recall on a case by case basis in consultation with the competent authority

Prevention

Appropriate investigations and corrective actions are required:

- Investigate the origin of the unsatisfactory results in order to avoid the reappearance of the microbiological contamination
- Measures may also include modifications to the HACCP-based procedures or other food hygiene control measures in place
- Environmental monitoring can form part of the investigatory action

Protect consumers health

Avoid outbreaks & recalls

Source: [6] and [7]

Overview food source reference methods

Bacteria	Possible food source (examples)	Analytical reference method	Enrichment*
Gram-negative bacteria			
1 *Salmonella*	Meats, poultry, eggs, milk and dairy products, fish, shrimp, spices, coconut, sauces, cake mixes, dried foods and fruit, peanut butter, cocoa, produce (fruits and vegetables), chocolate	ISO 10135:2013-05 (PCR) ISO 6579-1:2017-07	BPW 18 ± 2 h at 37 ± 1 °C
2 *Campylobacter* spp.	Improperly handled or undercooked poultry products, unpasteurized ("raw") milk and cheeses made from unpasteurized milk, shellfish	ISO 10272-1:2017-09	Bolton broth 4 - 6 h at 37 °C microaerobic, followed by 44 ± 4 h at 41.5 °C
Vibrio cholerae / parahaemolyticus	Raw or undercooked seafood, particularly oysters	ISO 21872-1:2017-10	ASPW with 2 % NaCl 1. Step: 6 ± 1 h at 41.5 ± 1°C (fresh food) or 37 ± 1°C (dried, frozen or salted food) 2. Step: 10 ml from first step in 90 ml preheated ASPW, 18 ± 1 h at 41.5 ± 1°C
Vibrio vulnificus	Raw or undercooked seafood, particularly oysters	ISO 21872-1:2017-10	ASPW with 2 % NaCl 1. Step: 6 ± 1 h at 37 ± 1 °C 2. Step: 10 ml from 1.) in 90 ml preheated ASPW, 18 ± 1 h at 37 ± 1 °C
3 *Yersinia enterocolitica*	Meats (pork, beef, lamb, etc.), oysters, fish, crabs and raw milk	ISO/TS 18867:2016-01 (PCR) ISO 10273:2017-08	Peptone-Sorbitol-Bile-Broth 48 h at 25 ± 1 °C
Cronobacter spp.	Infant formula	ISO 22964:2017-08	BPW 18 h ± 2 h at 34 °C to 38 °C
Pathogenic *Escherichia coli*			
E. coli	Raw or undercooked ground beef and beef products, raw milk, various water sources, lettuce, spinach, sprouts	–	BPW 16 - 24 h at 37 °C
E. coli – Enterohemorrhagic (E. coli O157:H7 and others)	Raw or undercooked ground beef and beef products, raw milk, various water sources, lettuce, spinach, sprouts	ISO/TS 13136:2012 (PCR), DIN SPEC 10794 ISO 16654:2017-08	mTSB or BPW 18 - 24 h at 37 ± 1 °C
Gram-positive bacteria			
4 *Listeria monocytogenes/ Listeria* spp.	Raw milk, inadequately pasteurized milk, chocolate milk, cheeses, ice cream, raw vegetables, raw poultry and meats, fermented raw-meat sausages, deli meats, and raw or smoked fish and other seafood	ISO 11290-1/2:2017-09	Half Fraser broth 25 ± 1 h at 30 ± 1 °C
5 *Staphylococcus aureus*	Meat and meat products; poultry and egg products, salads, bakery products, sandwich fillings, milk and dairy products	ISO 6888-1:2019-04	BPW 16 - 24 h at 37 °C
6 *Bacillus cereus*	A variety of foods, particularly (fried) rice and leftovers, as well as sauces, soups, and other prepared foods that have sat out too long at room temperature	ISO 17919:2013 / Messelhäusser et. al. 2014	TPGY 24 h ± 2 h at 30 ± 1 °C
7 *Clostridium botulinum*	The types of foods involved in botulism vary according to food preservation and cooking practices	ISO/TS 17919:2014-03	TPGY 1. Step: 24 ± 2 h at 30 ± 1 °C (real-time PCR test, if result negative: Step 2) 2. Step: 48 ± 2 h at 30 ± 1 °C
8 *Clostridium perfringens*	Meats (especially beef and poultry), meat-containing products, vegetable products, including spices and herbs, raw and processed foods, gravies - food left for long periods in steam tables or at room temperature for example	ISO 7937:2004	TPGY 48 h at 37 °C

* The enrichment conditions are only guidelines and may vary depending on the tested food matrices.
Please also consider national laws and regulations.

BPW - Buffered peptone water
ASPW - Alkaline Saline Peptone Water
mTSB - Modified Tryptone Soya Broth
TPGY - Tryptone Peptone Glucose Yeast Broth
n.a. - not applicable




Bacteria	Possible food source (examples)	Analytical reference method	Enrichment*
Virus			
Hepatitis A	Raw or undercooked shellfish from contaminated waters, raw produce, contaminated drinking water, uncooked foods, and cooked foods that are not reheated after contact with an infected food handler	ISO 15216-1:2017-07	n.a.
Norovirus	Produce, shellfish, ready-to-eat foods touched by infected food workers (salads, sandwiches, ice, cookies, fruit), any other foods contaminated with particles of vomit or feces from an infected person	ISO 15216-1:2017-07	n.a.

1 *Salmonella*

If a hen's reproductive organs are infected, the yolk of an egg can be contaminated in the hen before it is even laid

2 *Campylobacter* spp.

Foodborne *Campylobacter* infections have a characteristic seasonality with a distinct increase of cases in the summer and early autumn.

3 *Yersinia enterocolitica*

Up to date, there is a non-compulsory reporting on *Yersinia* and harmonized sampling and reporting rules do not exist yet.

4 *Listeria monocytogenes/ Listeria* spp.

Listeria have the ability to survive, multiply and persist under harsh conditions. They are for instance resistant to freezing, can growh in the presence of 10 % salt, survive in concentrated brine solutions, and are able to grow at 1 - 45 °C (optimum at 35 - 37 °C).

5 *Staphylococcus aureus*

S. aureus is a common bacterial pathogen causing staphylococcal food poisoning (SFP). SFP is not caused by consumption of live bacterial cells but rather picked up from ingesting one or more heatstable pre-formed staphylococcal enterotoxins (SEs) in foods contaminated with e.g. *S. aureus*. This so called intoxication does not need the bacterial growth in the host. SEs are unique, because they survive heating including canning.

6 *Bacillus cereus*

B. cereus intoxication has been linked to inappropriate food preparation and storagee. A slow cooling process due to large containers is often a factor.

7 *Clostridium botulinum*

Botulism is categorized into follwoing types:
- foodborne
- wound
- infant
- inhalation

There are 7 forms of botulinum toxin: types A - G. Types A, B, E and rarely F cause human botulism.

8 *Clostridium perfringens*

Spores of *C. perfringens* are able to survive normal cooking and pasteurization temperatures, after which they can then germinate and multiply during slow cooling, or storage at room temperatures and/or during inadequate re-warming. Sometimes it is referred to as the "food service germ", because foods served and left for long periods at room temperature have been linked with this illness.

Technical Glossary

Biofilm	Surface-associated multicellular communities that are enclosed in a self-produced extracellular matrix.
Botulism	Rare but serious illness (potentially fatal) caused by a neurotoxin produced by *Clostridium botulinum.*
Contamination	Pollution of an area or substance (e.g. food) with microorganisms or other undesirable material.
Emetic toxin	A toxin produced by *Bacillus cereus* which causes nausea and vomiting.
Endemic	A disease or condition that regularly occurs or is very common in a particular area or group.
Endotoxin	A heat-stable lipopolysaccharide which can be found in the outer membrane of the cell wall of Gram-negative bacteria (e.g. such as *E. coli*, *Salmonella*, *Shigella*, *Pseudomonas* or *Vibrio cholera*) and is released when the bacterium lyses or, sometimes, during growth, and is toxic and potentially fatal to the host.
Enterotoxin	A toxin secreted by bacteria that explicitly affect the intestinal cells and causes vomiting and diarrhea.
Epidemic	A widespread occurrence of an infectious disease affecting many persons at the same time.
Exotoxin	Diffusional proteins, usually from Gram-positive bacteria and secreted into the external environment and are potent toxins.
Food intoxication	A form of food poisoning caused by the consumption of food containing microbial toxins produced prior to consumption under favorable conditions. Living microorganisms are not necessarily present.
Food poisoning	Illness caused by eating contaminated food, whether by a pathogen, toxin, or chemical.
Foodborne infection	Food poisoning caused by consumption of foods contaminated with living, pathogenic microorganisms.
Foodborne transmission	Distribution of pathogenic microorganisms or toxins present in foods that were inadequately prepared or stored.
Gram-negative bacteria	Gram negative bacteria have cell walls with only a thin layer of peptidoglycan and an outer membrane with a lipopolysaccharide component not found in Gram positive bacteria. Gram staining results in red or pink, because the thin layer of peptidoglycan does not retain the initial crystal violet dye.
Gram-positive bacteria	Gram positive bacteria have cell walls composed mostly of peptidoglycan. Gram staining results in purple.
Infection	Invasion and multiplication of microorganisms such as pathogenic bacteria or viruses within a host

References

[1] Centers for Disease Control and Prevention (CDC), Food Safety Homepage FDA “Bad Bug Book” http://vm.cfsan.fda.gov

[2] Behlinhg J., Kornacki L. (ed.), Principles of Microbiological Troubleshooting in the Industrial 5 Food Processing Environment, Food Microbiology and Food Safety, Chapter 2: Selected Pathogens of Concern to Industrial Food Processors: Infectious, Toxigenic,Toxico-Infectious, Selected Emerging Pathogenic Bacteria DOI 10.1007/978-1-4419-5518-0_2,

[3] Jasson V, Jacxsens L, Luning P, Rajkovic A, Uyttendaele M, Alternative microbial methods: An overview and selection criteria, Food Microbiology, Volume 27, Issue 6, 2010, 710-730

[4] Mooijman K A, Pielaat A, Kuijpers AFA, Validation of EN ISO 6579-1 - Microbiology of the food chain – Horizontal method for the detection, enumeration and serotyping of Salmonella - Part 1 detection of Salmonella spp., International Journal of Food Microbiology 288, 2019, 3–12

[5] EFSA Journal, EU summary report on zoonoses, zoonotic agents and food-borne outbreaks 2017

[6] Meat Industry Guide, Chapter 13 Microbiological Criteria, September 2017

[7] Chilled Food Association Ltd, Guidance on the Practical Implementation of the EC Regulation on Microbiological Criteria for Foodstuffs – Edition 1.2, Dec2006

Product Overview

Bacteria

Product	Description*	No. of Tests/Amount	Art. No.
	DNA preparation		
SureFast® PREP Bacteria	Preparation of bacteria DNA from enrichments	100 preparations	F1054
SureFast® Speed PREP	Speed preparation of bacteria- and parasites-DNA from enrichment cultures and tissue samples	100 preparations	F1021
SureFast® PREP Salmonella	DNA preparation of *Salmonella*	100 preparations	F1007
SureFast® Mag PREP Pathogen	Automated viral and bacterial nucelic acid preparation in combination with TANBead Maelstrom 8 Autostage (ZMAL8) or Maelstrom 4800 (ZMAL48)	96 preparations	F1062
Salmonella	**Qualitative real-time PCR - food related pathogens**		
SureFast® Salmonella PLUS	FAM: *Salmonella* spp.	100 reactions	F5111
SureFast® Salmonella ONE MicroVal (2014LR43; ISO 16140-2) AOAC-RI (081803)	FAM: *Salmonella* spp.	100 DNA preparations & 100 reactions	F5211
SureFast® Salmonella species/Enteritidis/ Typhimurium 4plex	FAM: *Salmonella* spp. ROX: *Salmonella* Enteritidis Cy5: *Salmonella* Typhimurium	100 reactions	F5166
Escherichia coli			
SureFast® Escherichia coli PLUS	FAM: *Escherichia coli*	100 reactions	F5157
SureFast® EHEC/EPEC 4plex (stx1, stx 2, ipaH, E.coli/Shigella)	FAM: *stx1* (subtype a-d) & *stx2* (subtype a-g) Cy5: *eae* ROX: *ipaH* (*E. coli* & *Shigella* spp.)	100 reactions	F5128
SureFast® STEC Screening PLUS	FAM: *stx1*/*stx2*	100 reactions	F5105
SureFast® STEC 4plex ONE (0157, stx1, stx2, eae)	FAM: *E. coli stx1* (*subtype a-d*) & *stx2* (*subtype a-g*) Cy5: *eae* ROX: *E. coli* O157	100 reactions	F5265
SureFast® Escherichia coli Serotype I 4plex	FAM: O121 Cy5: O26 ROX: O103	100 reactions	F5167
SureFast® Escherichia coli Serotype II 4plex	FAM: O45 Cy5: O145 ROX: O111	100 reactions	F5168
Listeria			
SureFast® Listeria Screening PLUS	FAM: *Listeria* spp.	100 reactions	F5117
SureFast® Listeria monocytogenes PLUS	FAM: prfA-gene of *L. monocytogenes*	100 reactions	F5113
Bacillus cereus			
SureFast® Bacillus cereus group PLUS	FAM: *Bacillus cereus* group (*B. anthracis, B. cereus, B. cytotoxis, B. mycoides, B. pseudomycoides, B. thuringiensis* & *B. weihenstephanensis*)	100 reactions	F5126
SureFast® Emetic Bacillus cereus PLUS	FAM: Specific cereulide synthetase DNA sequence of the emetic *Bacillus cereus*	100 reactions	F5127
Campylobacter			
SureFast® Campylobacter PLUS	FAM: *Campylobacter* (*C. jejuni, C. lari, C. coli*)	100 reactions	F5112
Clostridium			
SureFast® Clostridium botulinum Screening PLUS	FAM: Botulinum neurotoxins (BoNT) A, B, E & F of *C. botulinum*, *C. baratii* & *C. butyricum*	100 reactions	F5110
SureFast® Clostridium estertheticum PLUS	FAM: *Clostridium estertheticum*	100 reactions	F5160
SureFast® Clostridium perfringens PLUS	FAM: Specific alpha-toxi n DNA sequence of *Clostridium perfringens*	100 reactions	F5123
Cronobacter			
SureFast® Cronobacter PLUS	FAM: *Cronobacter* spp.	100 reactions	F5114
SureFast® Cronobacter sakazakii PLUS	FAM: *Cronobacter sakazakii*	100 reactions	F5115

Bacteria

Product	Description*	No. of Tests/Amount	Art. No.
Staphylococcus			
SureFast® Staphylococcus aureus PLUS	FAM: *Staphylococcus aureus*	100 reactions	F5116
MRSA			
SureFast® MRSA 4plex	FAM: *SCCmec/orfX* ROX: *Staphylococcus aureus* Cy5: *mecA/mecC*	100 reactions	F7117
Vibrio			
SureFast® Vibrio 4 plex (V. cholerae, V. parahaemolyticus, V. vulnificus + IAC)	FAM: *Vibrio cholerae* ROX: *Vibrio parahaemolyticus* Cy5: *Vibrio vulnificus*	100 reactions	F5161
Yersinia			
SureFast® Yersinia 3plex	FAM: *Y. pseudotuberculosis* Cy5: *Y. enterolitica*	100 reactions	F5132

Viruses

	DNA preparation		
SureFast® Mag PREP Pathogen	Automated viral and bacterial nucelic acid preparation in combination with TANBead Maelstrom™ 8 Autostage (ZMAL8) or Maelstrom™ 4800 (ZMAL48)	96 preparations	F1062
SureFast® DNA/RNA Virus	DNA preparation of viruses	100 preparations	F1051
	Qualitative real-time PCR - food related viruses		
SureFast® Norovirus/Hepatitis A 3plex	FAM: Norovirus (genogroup I & II) Cy5: Hepatitis A	100 reactions	F7124
SureFast® Hepatitis A PLUS	FAM: Hepatitis A	100 reactions	F7125
SureFast® Hepatitis E PLUS	FAM: Hepatitis E	100 reactions	F7142
SureFast® SARS-CoV-2 PLUS AOAC 022102	FAM: SARS-CoV-2	100 reactions	F7110

Water analysis

	DNA preparation		
SureFast® PREP Aqua	DNA preparation of bacterial cells from water samples	100 preparations	F1023
	Qualitative real-time PCR - water related pathogens		
SureFast® Legionella pneumophila PLUS	FAM: *Legionella pneumophila*	100 reactions	F5501
SureFast® Legionella Screen PLUS	FAM: *Legionella* spp.	100 reactions	F5502
SureFast® Legionella 3plex	FAM: *Legionella* spp. Cy5: *Legionella pneumophila*	100 reactions	F5505
SureFast® Pseudomonas aeruginosa PLUS	FAM: *Pseudomonas aeruginosa*	100 reactions	F5503
SureFast® Parasitic Water Panel 4plex	FAM: *Giardia intestinalis* ROX: *Entamoeba histolytica* Cy5: *Cryptosporidium* spp.	100 reactions	F5506
SureFast® Enterobacteriaceae Screening PLUS	FAM: *Enterobacteriaceae*	100 reactions	F5507

* VIC/HEX: Internal Amplification control (IAC)

03/2021