



# International Commission on Microbiological Specifications for Foods (ICMSF)

[www.icmsf.org](http://www.icmsf.org)

## Complexity of useful microbiological sampling & testing

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ICMSF Member since 2005

Chair since 2020



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# Why different types: it is not black and white



indicators / hygiene indicators

toxigenic organisms / infective organisms

target group: general population, infants, medicinal food

potential after sampling point (inactivation, stable, growth)



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# 50 shades of red



Total Plate Count

Mesophiles

(Hygiene) Indicators

*Enterobacteriaceae*

*Bacillus cereus*

*Campylobacter* in raw poultry

Inactivation after  
sampling point

*Salmonella* in raw poultry

*Salmonella* in RTE food

*Salmonella* in PIF

Target group: infants



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RTE= Ready to Eat    PIF = Powdered Infant Formula



# Types of sampling plans

Qualitative

2-class

Food Safety Criteria

Quantitative

3-class

Process Hygiene Criteria



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# Types of sampling plans

Qualitative

2-class

Food Safety Criteria

Quantitative

3-class

Process Hygiene Criteria

Qualitative: +/-: 0/25g

Quantitative:  $\leq 100$  cfu/g or  $>100$  cfu/g



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cfu = colony forming units



# Types of sampling plans

Qualitative

2-class

Food Safety Criteria

Quantitative

3-class

Process Hygiene Criteria

Qualitative: +/-: 0/25g

Quantitative:  $\leq 100$  cfu/g or  $>100$  cfu/g

2-class: +/- or  $x \leq 100$  cfu/g ;  $x > 100$  cfu/g

3-class:  $x < 500$  /g;  $500 < x \leq 5000$ ;  $x > 5000$ /g



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# Types of sampling plans

Qual/Quant	Qual	Quant	Quant	Qual/Quant
Class	2	2	3	3
Example	<i>Salmonella</i> in PIF	<i>Listeria</i> in no growth RTE	<i>Mesophiles</i> in PIF	3-class mixed



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Food Safety Criterion  
Process Hygiene Criterion



# Sampling plan: Food Safety Criterion

Food category: powdered infant formulae (PIF)

Microorganism	Sampling plan		Sample weight (g)	Analytical method
	$n$	$c$		
<i>Salmonella</i>	60	0	25	ISO 6579

CODEX Code of hygienic practice for powdered formulae for infants and young children  
CAC/RCP 66-2008



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Qualitative, 2-class,  $c=0$

Is there one or more *Salmonella* (detected) in my 25 g





# Sampling plan: Process Hygiene Criterion

Food category: powdered infant formulae (PIF)

Micro-organism	Sampling plan		<i>m</i>	<i>M</i>	Analytical method
	<i>n</i>	<i>c</i>			
<i>Enterobacteriaceae</i>	10	2	0/10 g	-	ISO 21528-1/21528-2

CODEX Code of hygienic practice for powdered formulae for infants and young children  
CAC/RCP 66-2008



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Qualitative, 2-class,  $c \neq 0$

Is there one or more enteros (detected) in my 10 g



# Sampling plan: Food Safety Criterion

Ready-to-eat foods from the end of manufacture or port of entry (for imported products), to the point of sale

Micro-organism	Sampling plan		$m$	$M$	Analytical method
	$n$	$c$			
<i>Listeria monocytogenes</i>	5	0	100 cfu/g	-	ISO 11290-2

CODEX Guidelines on the application of general principles of food hygiene to the control of *Listeria monocytogenes* in foods  
CAC/GL 61 - 2007



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Quantitative, 2-class,  $c=0$   
are there more than 100 cfu/g of *Listeria* in my sample



# Sampling plan: Process Hygiene Criterion

## *Campylobacter* on broilers

Micro-organism	Sampling plan		$m$	$M$	Analytical method
	$n$	$c$			
<i>Campylobacter</i> spp.	50	15*	1000 cfu/g	-	ISO 10272-2

\* c-value increased stringency: 2018:  $c=20$ ; 2020:  $c=15$ ; 2025:  $c=10$   
EC regulation 2073/2005



Quantitative, 2-class,  $c \neq 0$   
are there  $>1000$  cfu/g of *Campylobacter* in my sample



# Sampling plan: Process Hygiene Criterion

Food category: powdered infant formulae (PIF)

Micro-organism	Sampling plan		$m$	$M$	Analytical method
	$n$	$c$			
Mesophiles	5	2	500/g	5000/g	ISO 4833

CODEX Code of hygienic practice for powdered formulae for infants and young children  
CAC/RCP 66-2008



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Quantitative, 3-class,  $c \neq 0$



# Sampling plan: Food Safety Criterion

Potential criterion for *Listeria monocytogenes* in RTE food\*

Micro-organism	Sampling plan		<i>m</i>	<i>M</i>	Analytical method
	<i>n</i>	<i>c</i>			
<i>Listeria monocytogenes</i>	5	1	0/25 g	100 cfu/g	ISO 11290-1 ISO 11290-2

3-class,  $c \neq 0$ , qualitative and a quantitative limit

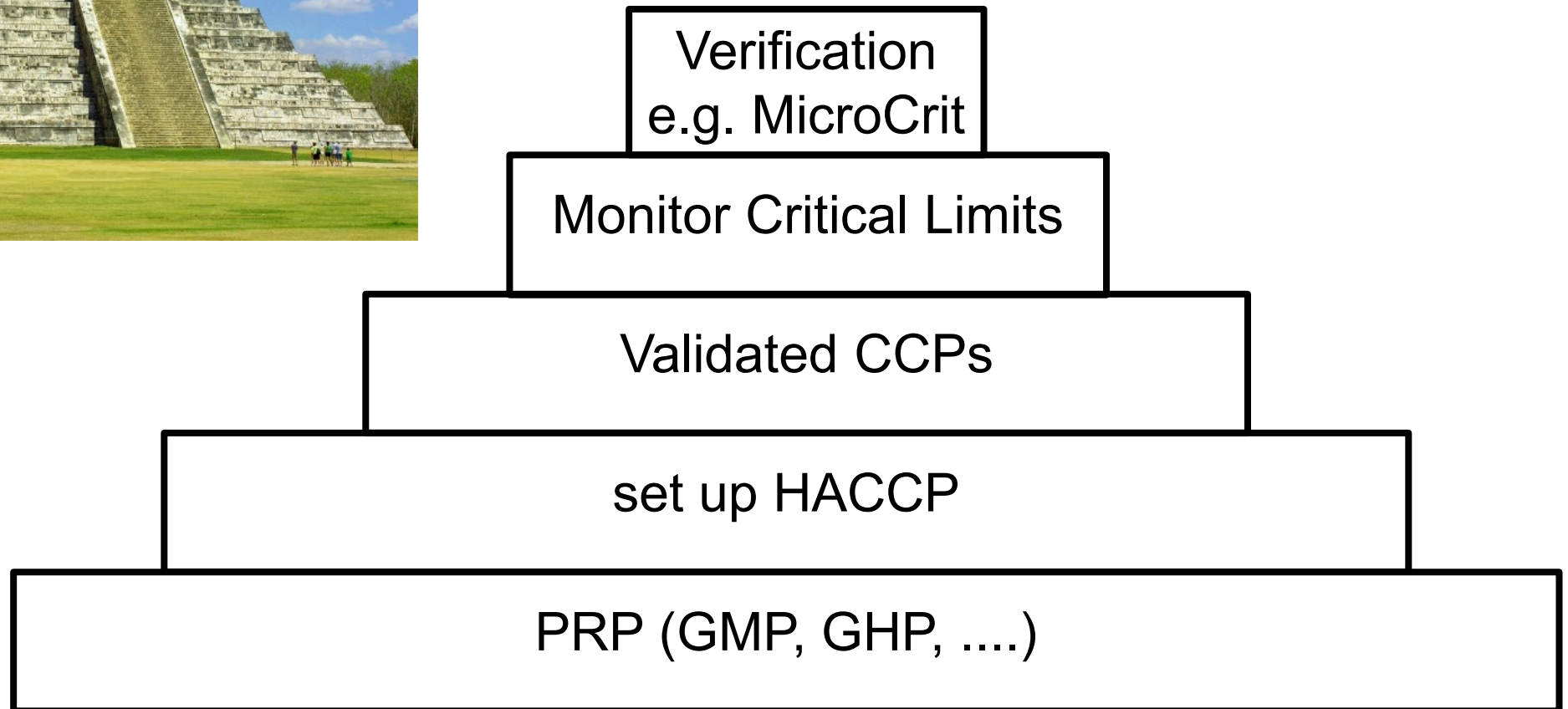


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\*Alternative approaches to the risk management of *Listeria monocytogenes* in low risk foods.



# Testing is not the basis of food safety

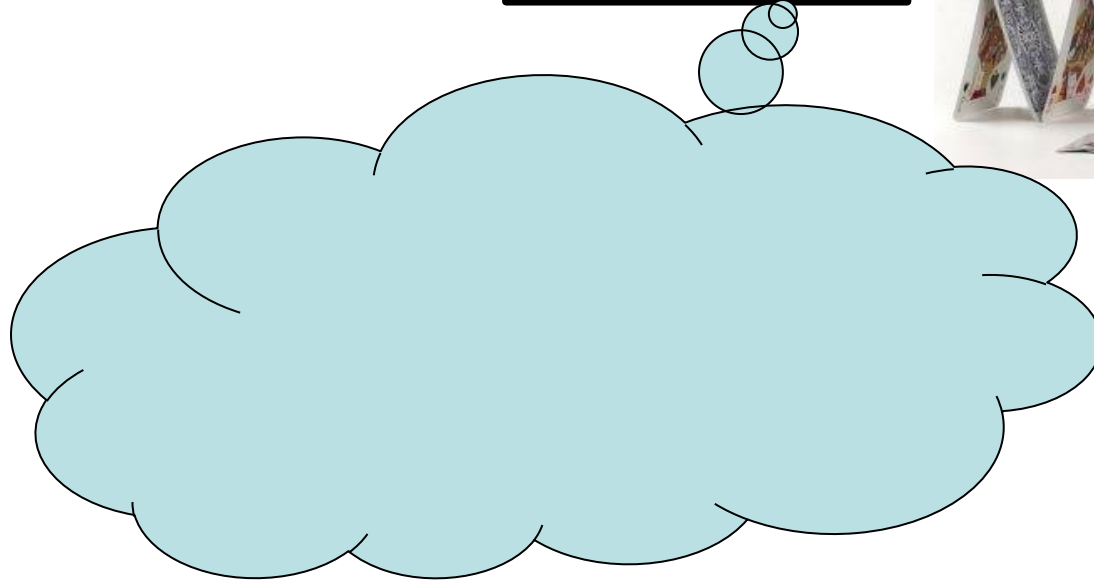


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# Testing is not the basis of food safety

verification  
by MicroCrit



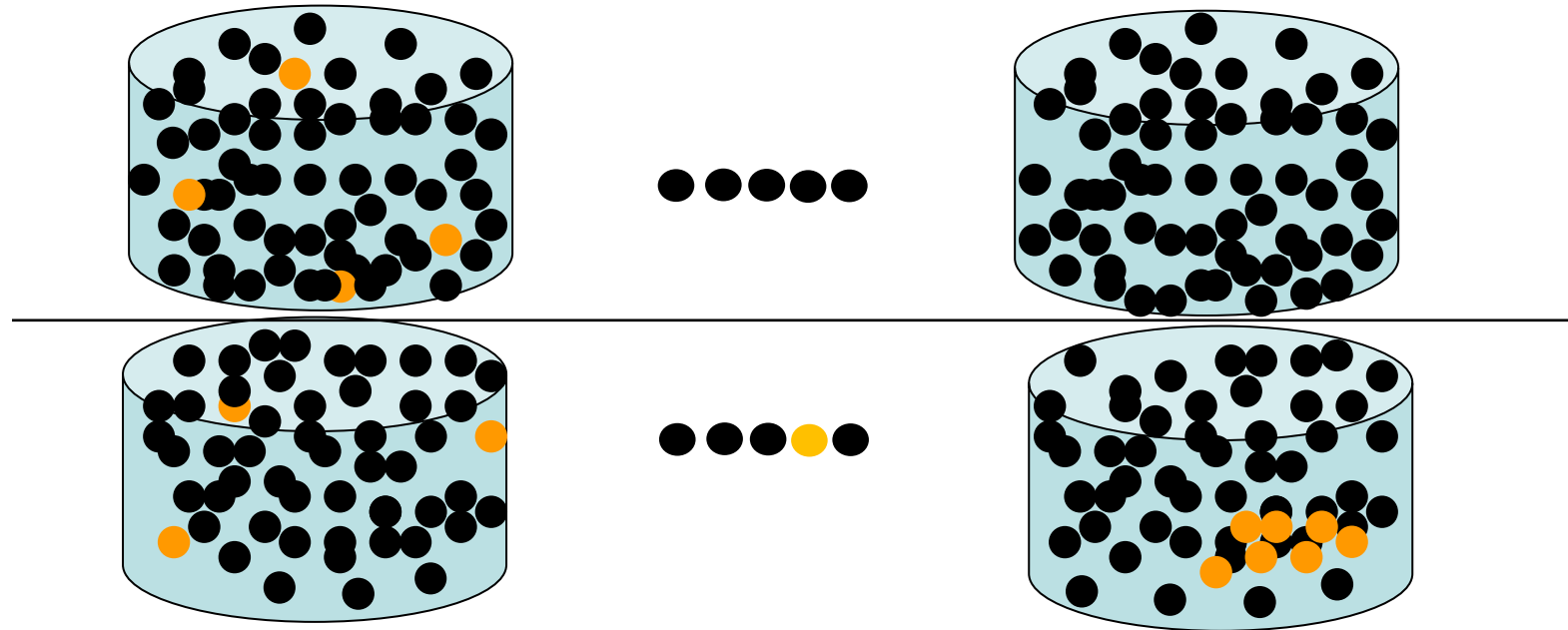
Only testing is not solid



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# End product testing useful or lottery ?



Positives mean something, negatives are no guarantee

**MISCONCEPTION:** *If the tested sample units are negative, the batch is free of the pathogen.*



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## Three statistical phenomena are relevant:

- The actual spatial distribution of microorganisms in the food batch,
- The statistical process of taking a sample unit and this being defective
- The acceptance of the lot based on  $n$  sample units, of which  $c$  are accepted to be positive and  $P_{defective}$

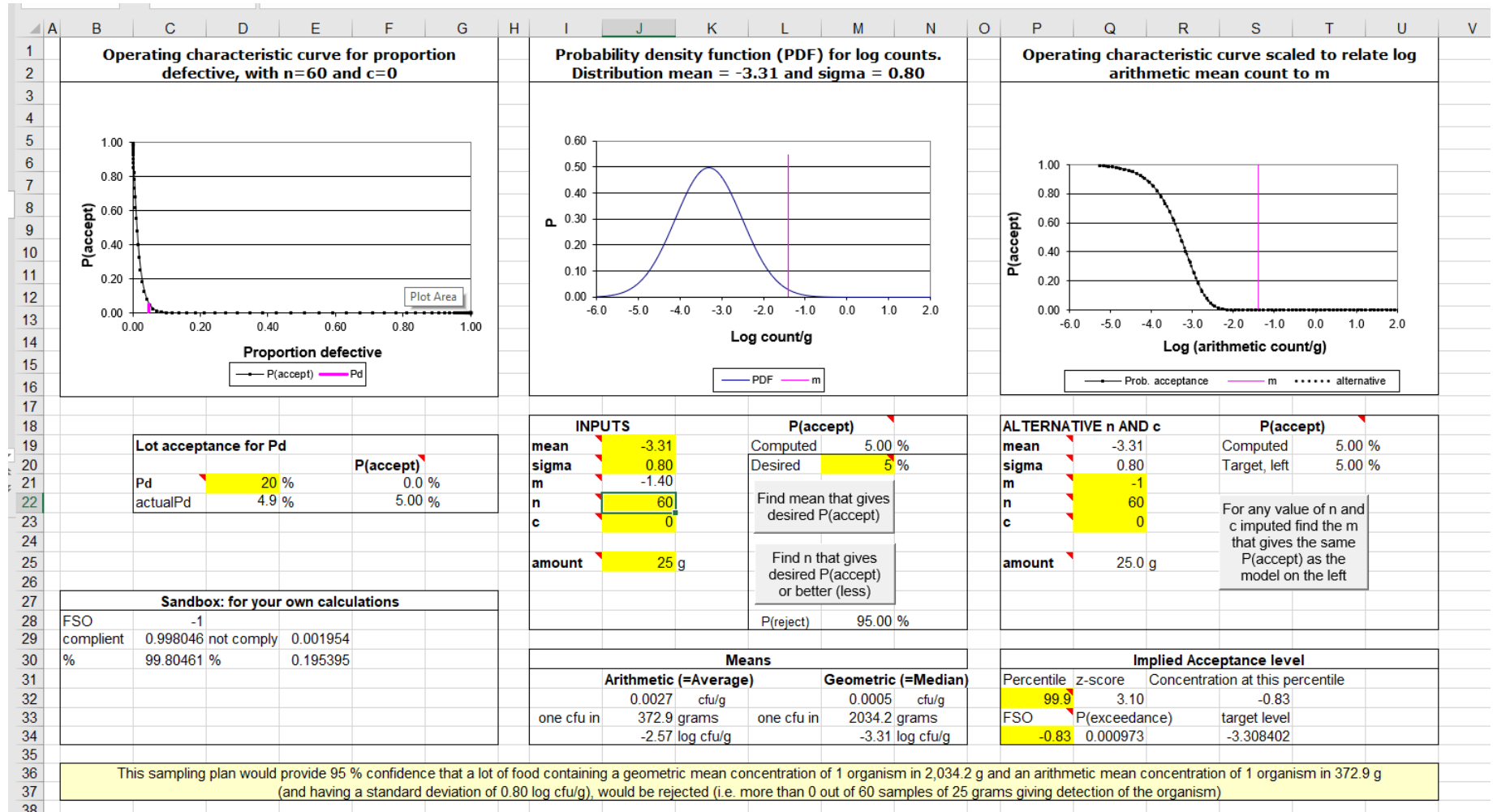
### For example:

1. Assumption: "Micro-organism are lognormally distributed in food products"
2. Taking one sample is a Poisson process, so  $P_{defective}$  is a Poisson-lognormal distribution of contaminant in the sample unit
3.  $P_{accept}$  of a lot based on  $P_{defective}$ ,  $n$  sample units, and  $c$  is a binomial process
4.  $P_{accept}$  is then a Binomial(Poisson(LogNormal)) distribution !





# The ICMSF Tool



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2-class enrichment

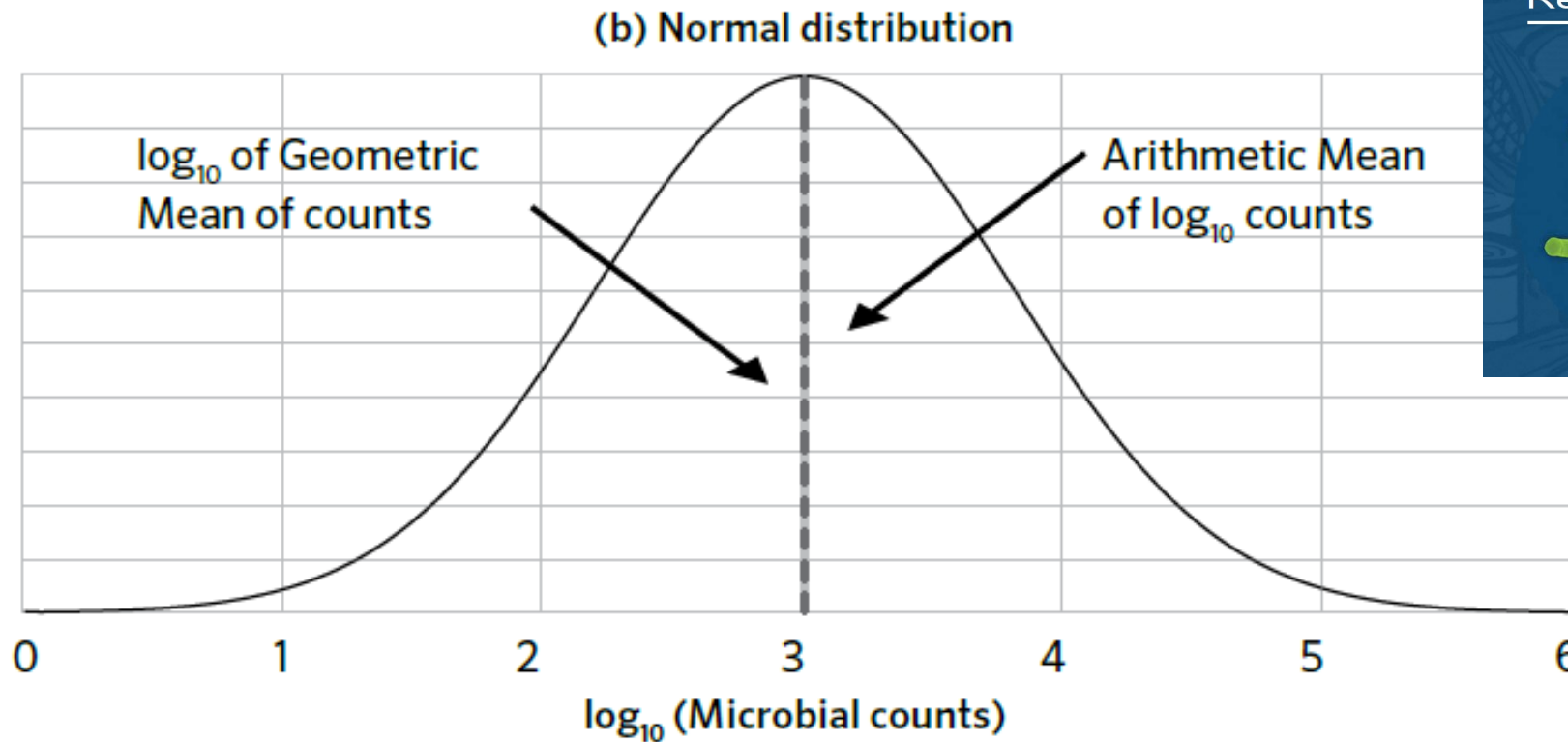
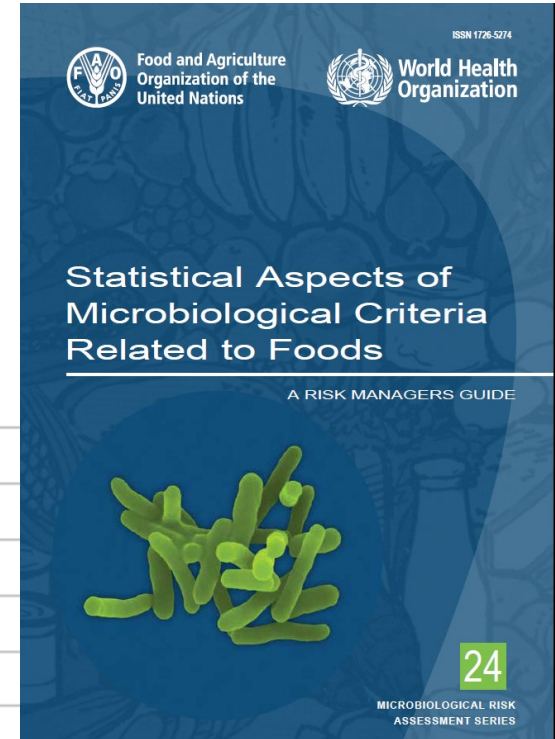
2-class counts

3-class counts

3-class mixed



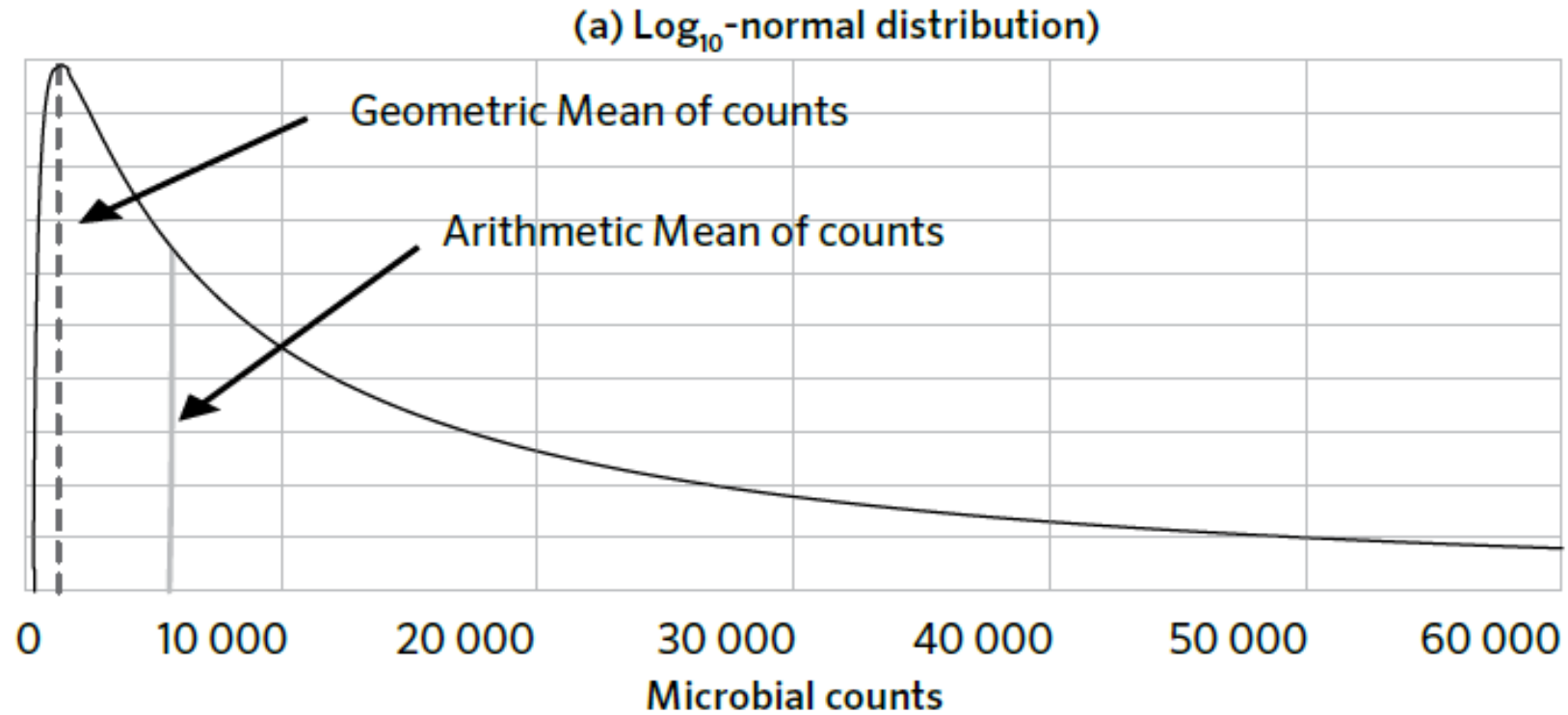
# Arithmetic of Geometric mean ?



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# Arithmetic of Geometric mean ?

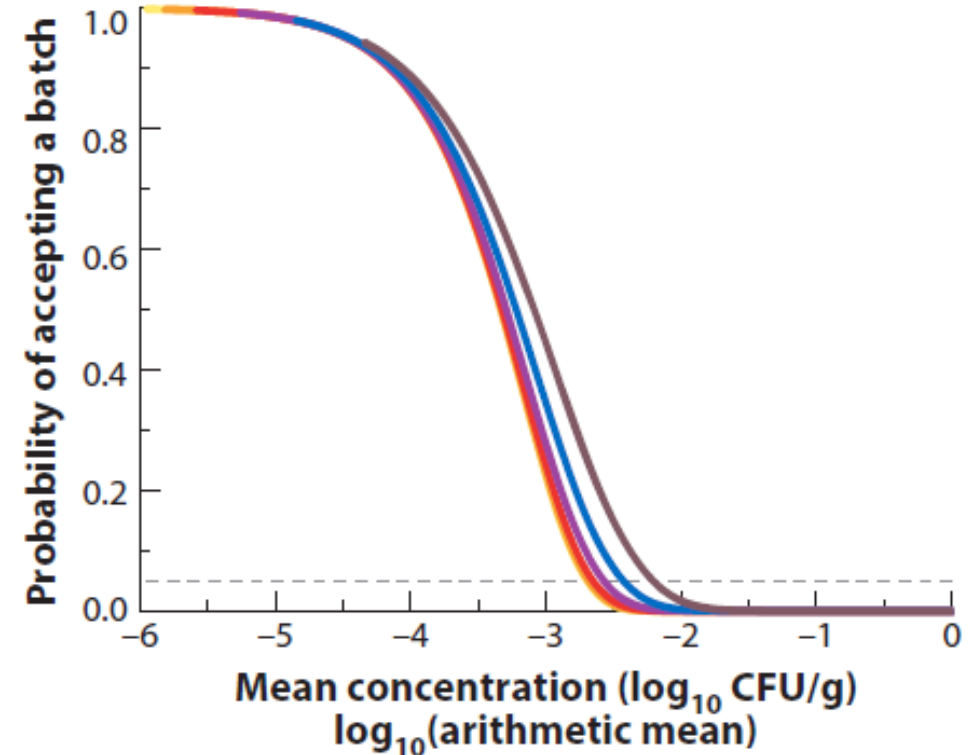
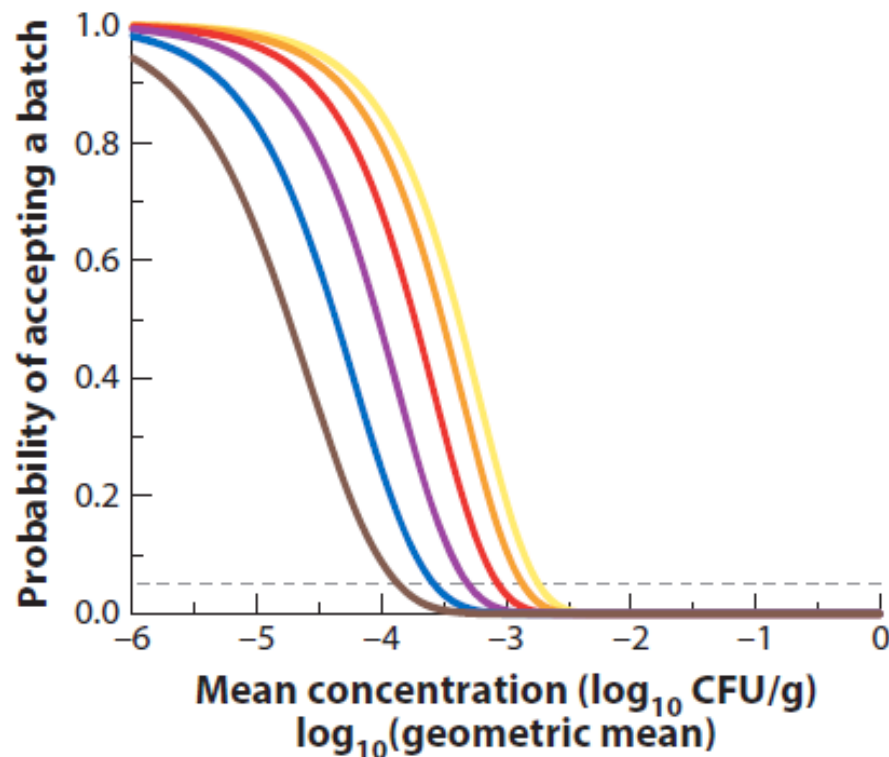


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# Performance of a sampling plan: The OC curve

$n=60$ ;  $\sigma = 1.2$  (brown), 1.0 (blue), 0.8 (purple), 0.6 (red), 0.4 (orange), and 0.2 (yellow)  $\log_{10}$  CFU/g.



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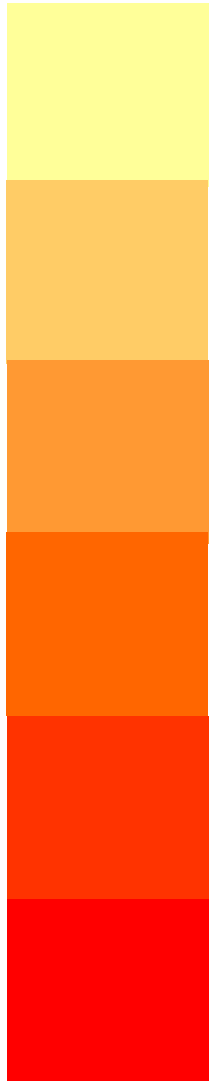
# If life would be easy

- Safety / Hygiene / Spoilage ?
- Pathogen or indicator ?
- qualitative/quantitative ?
- 2-class/3-class ?
- Arithmetic or geometric mean ?



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It depends .....





# If life would be easy

- Safety / Hygiene / Spoilage
- Pathogen or indicator: both (safety and hygiene)
- qualitative: for very infective organisms
- 3-class: if certain levels are acceptable
- Arithmetic or geometric mean: geometric to describe data, arithmetic for the performance



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# Complexity of useful microbiological sampling & testing

Einstein: Make everything as simple as possible.....

, but not simpler than that !

**Thank you for your attention**



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