How to prevent foodborne disease

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presented by

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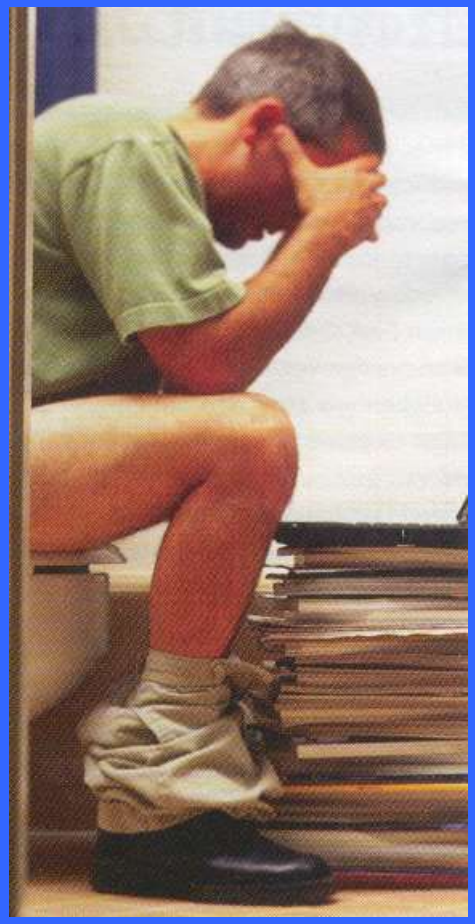
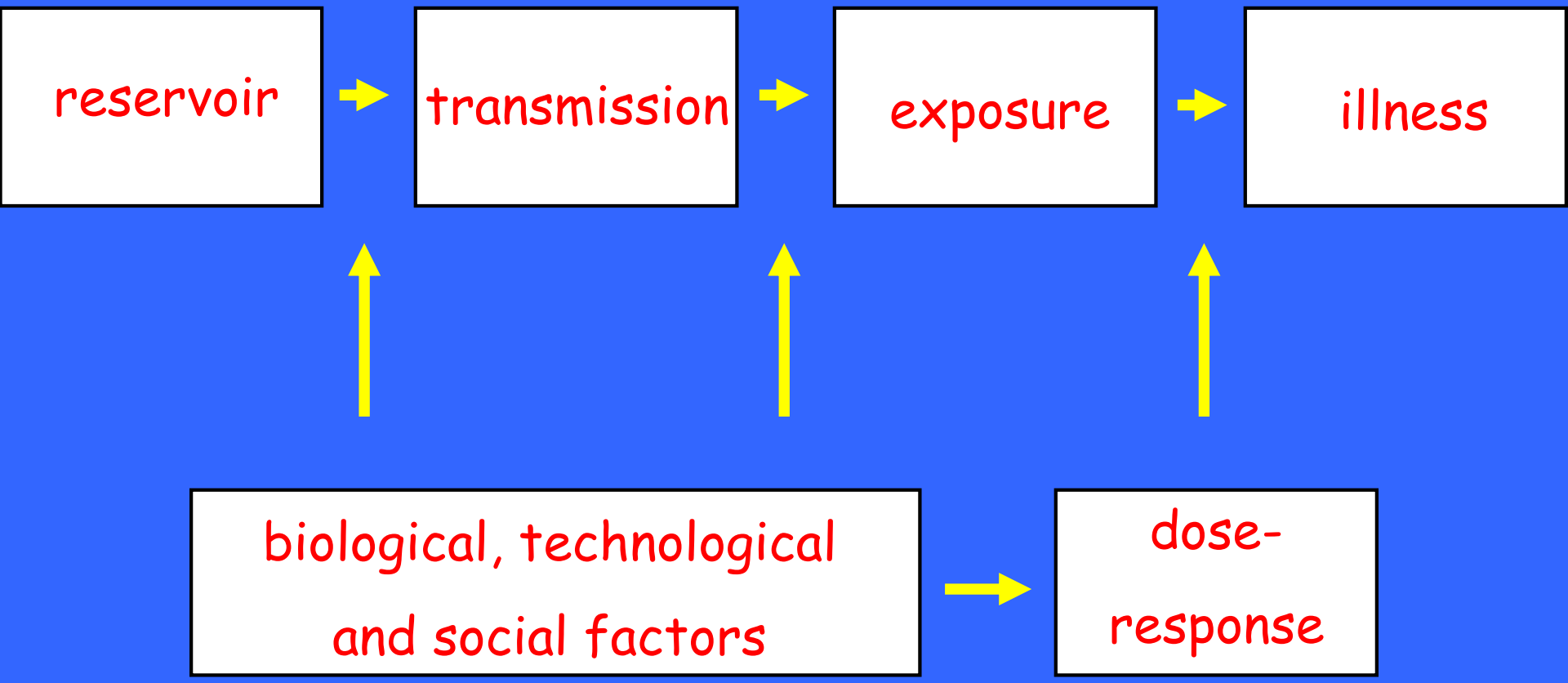
Some examples …



Pathways of foodborne infectious diseases



Transmission routes for enteric pathogens

Sources

* water, soil, air, waste	environmental
* food plants	foodborne
* food animals * pet animals * wild animals	foodborne direct
	human - human

Environmental transmission routes

direct contact of humans with contaminated:

* waste
* water
* soil
* air

Environmental transmission routes: tasks

* remove feces from the living space
* introduce a sewage system
* introduce water purification
* use well-composted animal feces
* prevent rodents, insects and dust to contact waste and food

As an example …. Sulabh foundation India

Foodborne transmission routes …

Contact of humans with contaminated food from:

* food plants
* food animals

Contaminated via:

* environment (nature, processing, domestic handling)

Foodborne transmission routes: tasks:

* describing environmental cycles
  (after source 'attributing')

* reliable detection and typing methods, for prevalence of pathogens in the environment, in food products, and in the population

* knowing the behavior of foodborne pathogens
  (survival, growth, inactivation, stress response, including behaviour in biofilms, and reaction on new methods, hygienic design)

* more practice-based experiments necessary, too many laboratory experiments

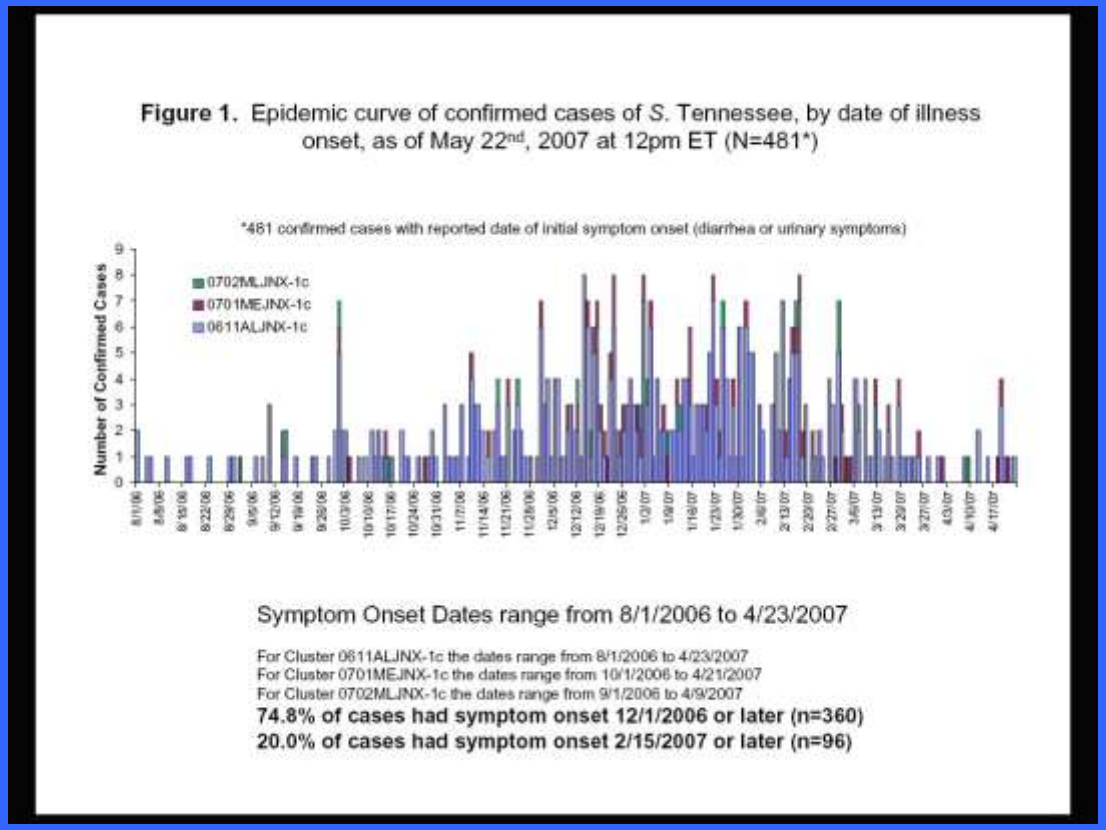
Transmission routes for pet/wild animals …

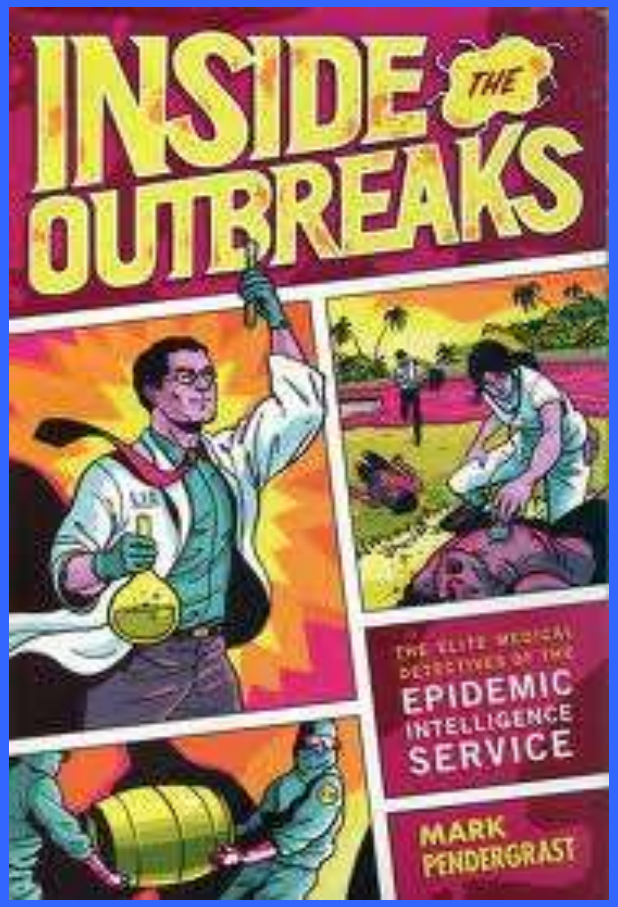
* direct contact (pets)

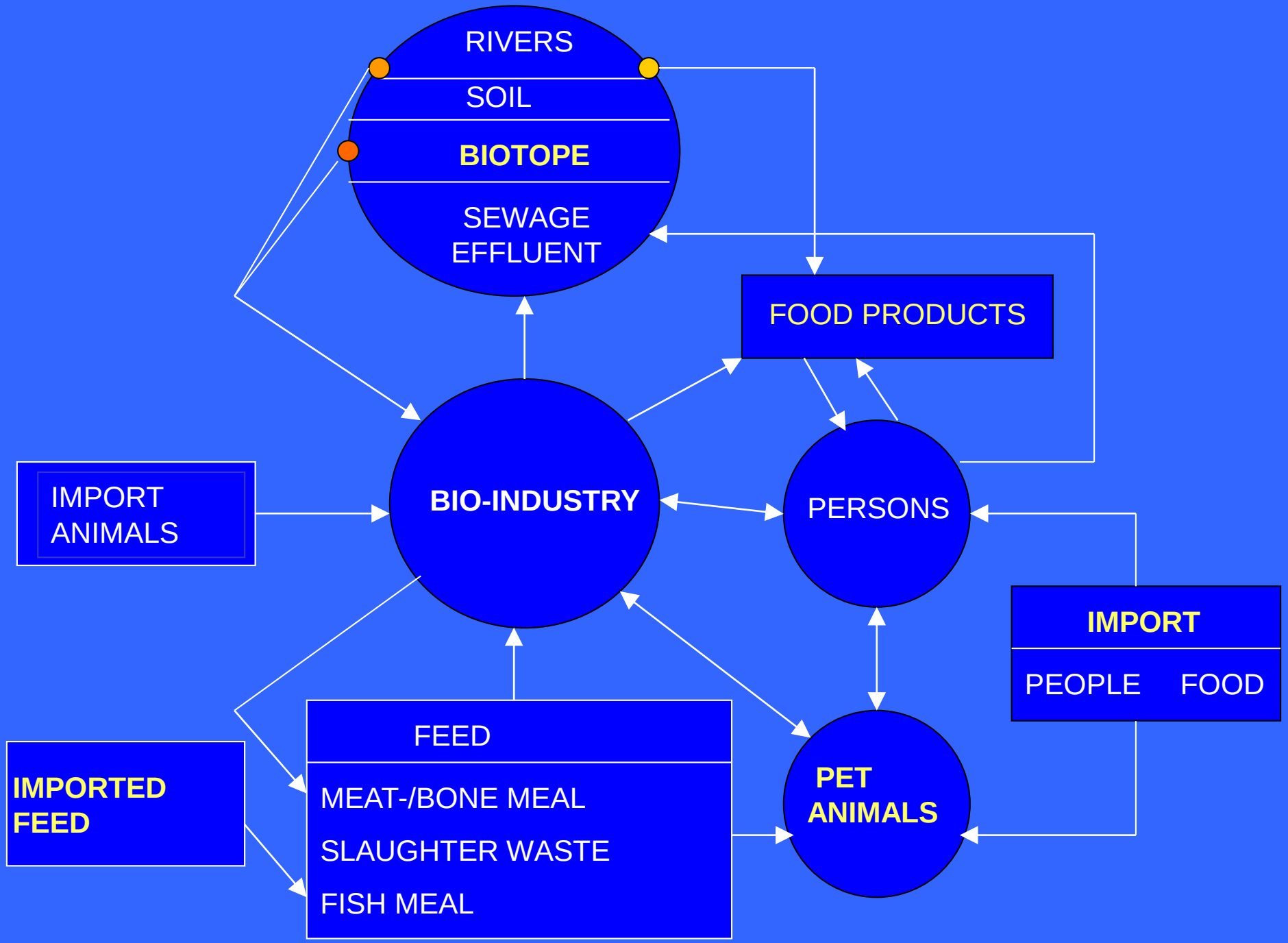
* (in)direct contact (wild) (bush meat)

Information for transmission routes …

Unfortunately, we need (large) outbreaks to gather sufficient and reliable information for source attribution and environmental cycles






RIVERS
SOIL
BIOTOPE
SEWAGE
EFFLUENT
FOOD PRODUCTS
IMPORT
ANIMALS
BIO-INDUSTRY
PERSONS
IMPORT
PEOPLE
FOOD
FEED
MEAT-/BONE MEAL
SLAUGHTER WASTE
FISH MEAL
IMPORTED
FEED
PET
ANIMALS

Prevention foodborne diseases

Short term

education consumers and producers

Long term

pathogen free animals feed and environment ???

Barriers on three levels:

Production

Processing

Consumer

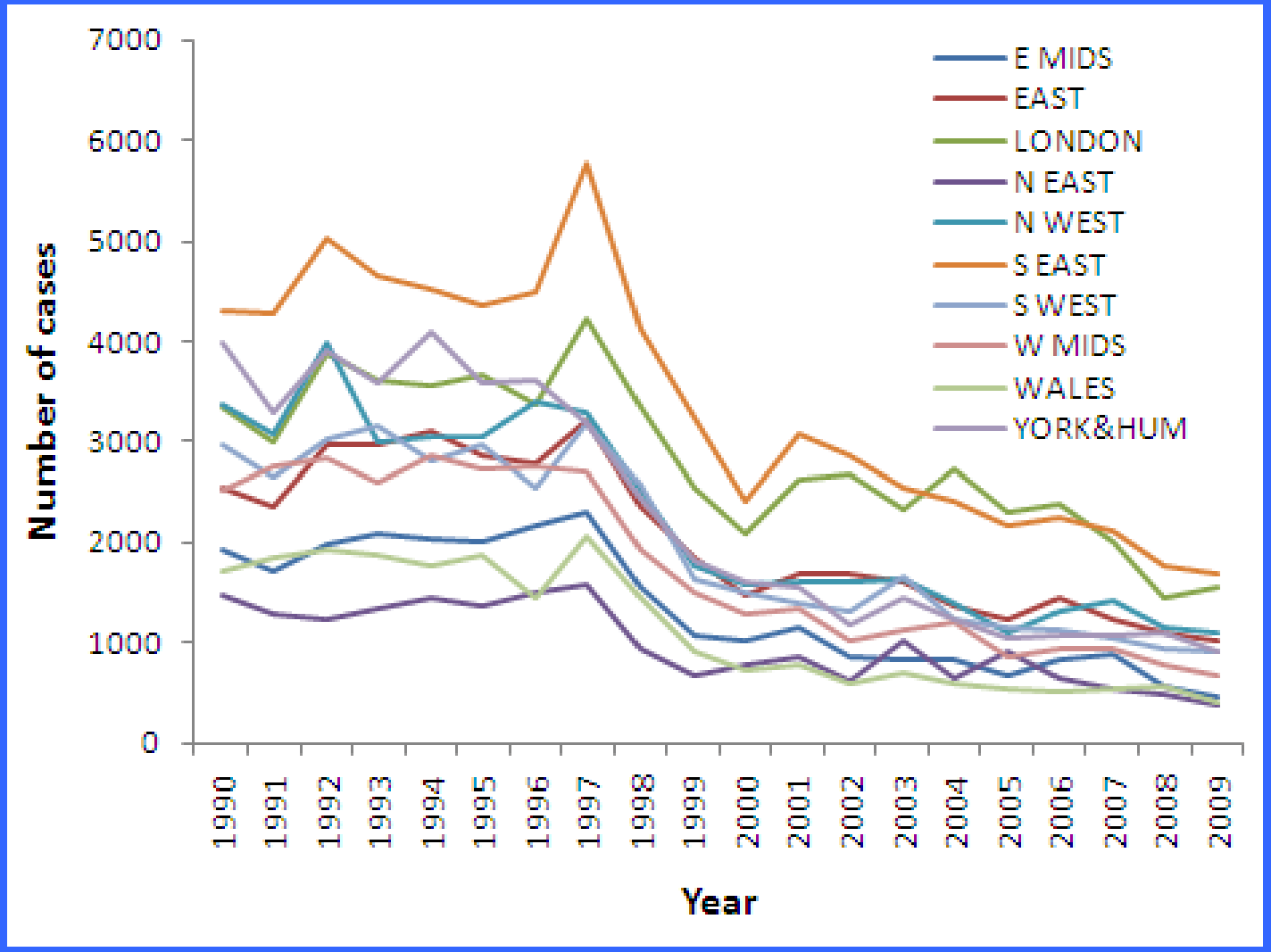
Instruction/education necessary on each level

* probably not wise to re-use waste water
* import raw materials

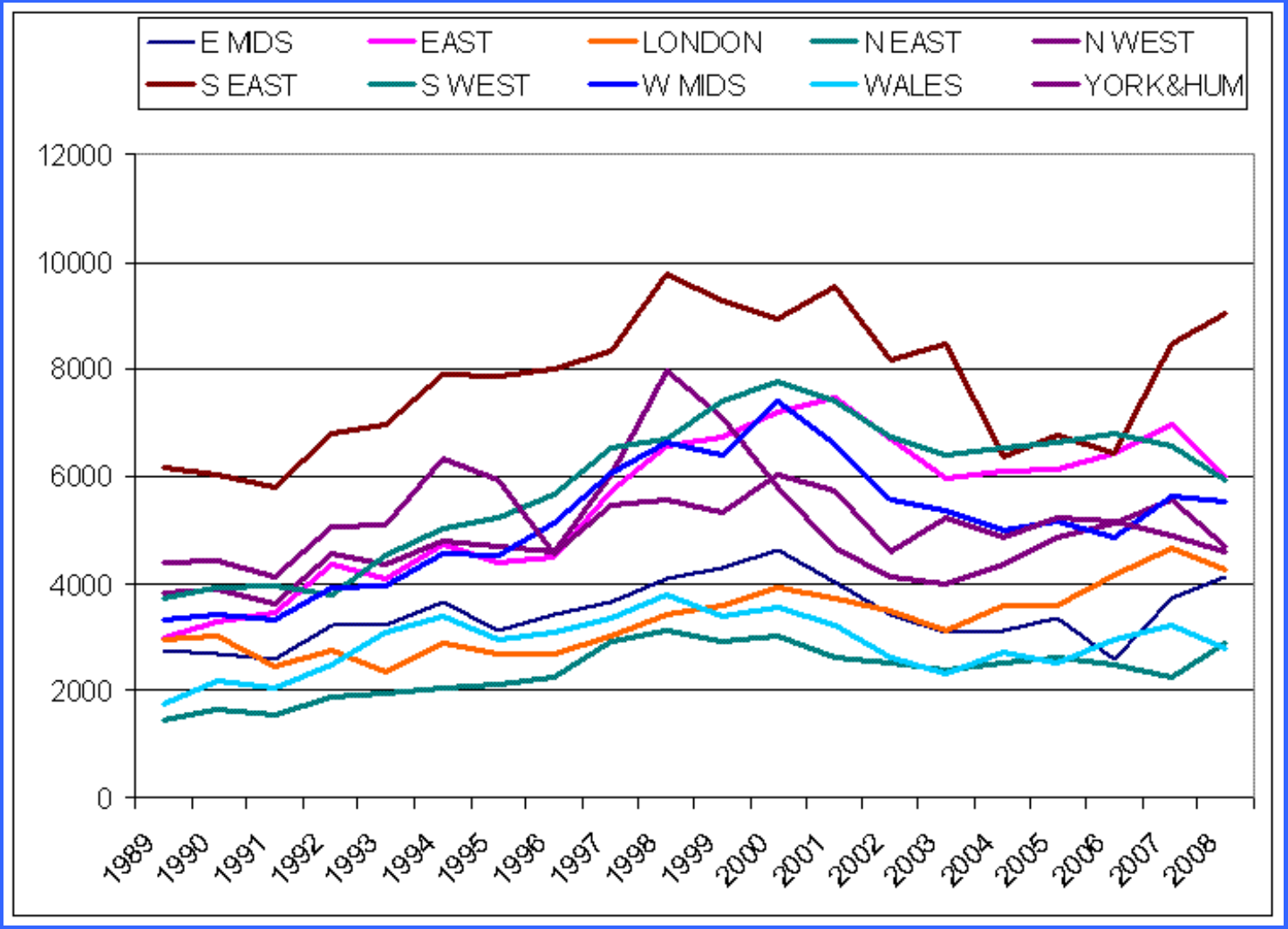
* hygienic design
* cleaning disinfection
* inactivation/preservation
* shelf life

* consumer education: starting asap

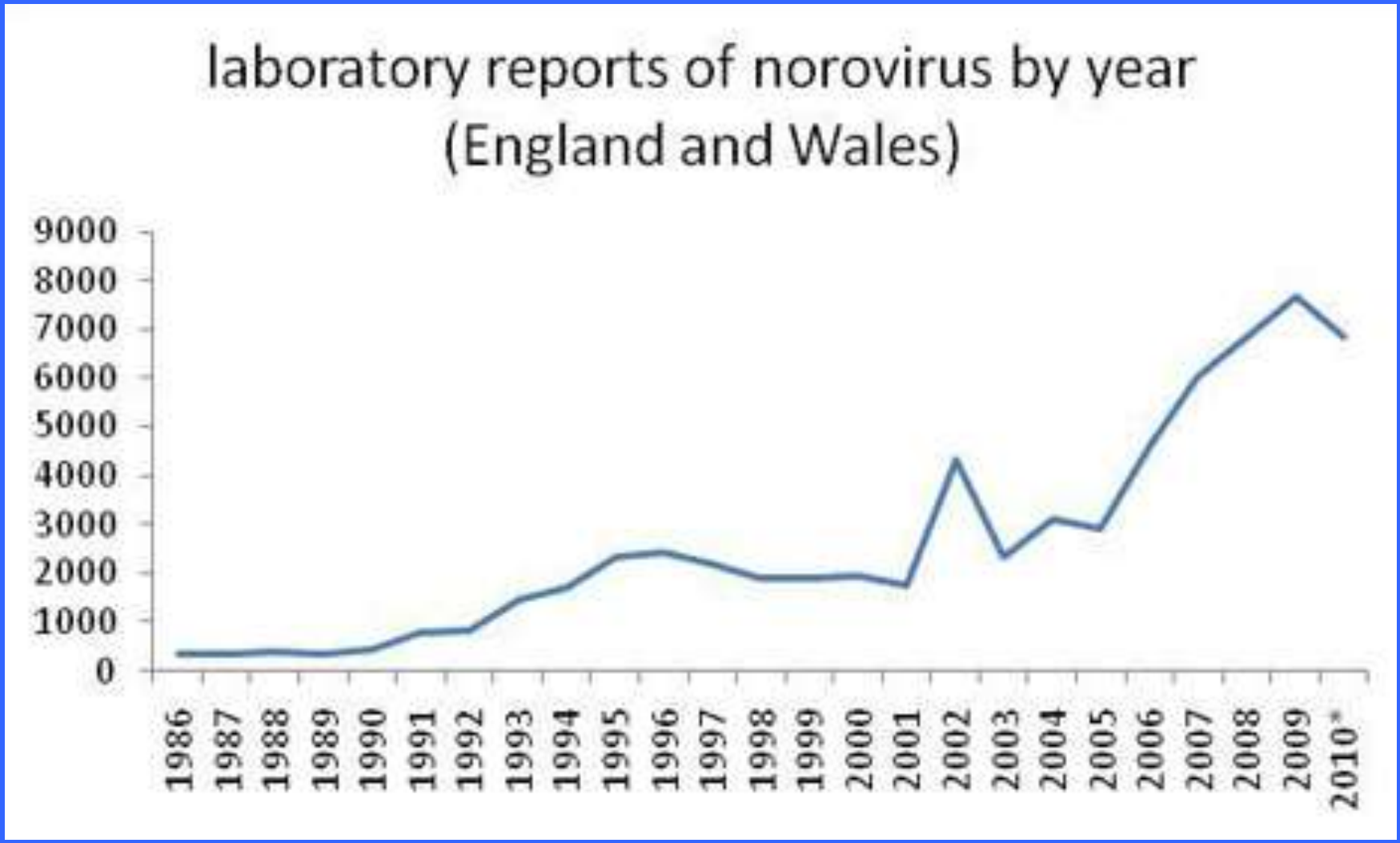
Outbreaks UK, decrease in *Salmonella*



Outbreaks UK, *Campylobacter*:



Outbreaks UK, increase in Norovirus



Number outbreaks and illnesses, US

	Outbreaks			Illnesses		
	2007		2002-2006	2007		2002-2006
	Conf	Total	T.mean	Conf	Total	T.mean
Bacterial						
SAL	136	142	144	3465	3515	3475
STEC	40	42	28	593	603	375
CAMP	21	27	22	346	372	624
Parasitic						
Total	5	5	9	65	65	279

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Some (important?) foodborne pathogens

The Burden of Foodborne Illness

Many cases of foodborne illness go unreported.

How many illnesses, hospitalizations, and deaths are caused by meat, poultry, and processed eggs?

Micro-organisms	Ill	Hospital	Dead (%)
Bacillus cereus	0.198	0.014	0
Cl. botulinum	0.00042	0.076	0.246
Cl. perfringens	1.8	0.064	0.360
Staph. aureus	1.3	2.9	0.107
L. monocytogenes	0.018	3.8	27.5
Campylobacter	14.2	17.3	5.7
Salm. non typh.	9.7	25.7	30.4
E. coli	1.3	4.6	4.3
Vibrio	0.038	0.203	1.7
Yersinia entero.	0.628	1.8	0.126

Most important foodborne pathogens

* Campylobacters	poultry, pork, milk
* Salmonellas	poultry, meat, milk vegetables
* *E. coli O157*	cattle
* *L. monocytogenes*	cheese, smoked fish cooked meat products
* *Staph. aureus*	humans
* Viruses	vegetables, humans

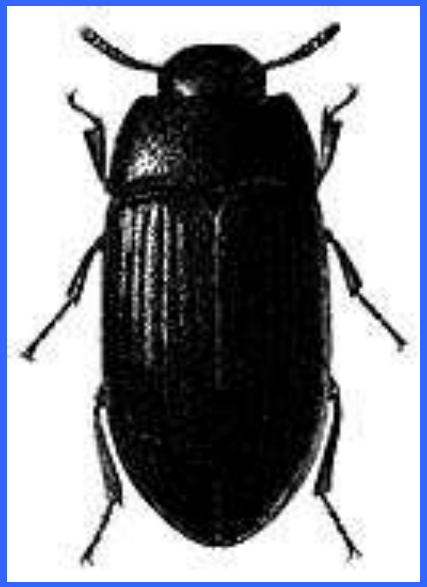
Goal of outbreak surveillance

* prevention of future outbreaks
* more insight in process of disease
* evaluation of measures for prevention
* evaluation of investigations of outbreaks
* insight in prevailing outbreaks

Chicken… and its pathogens

* Campylobacters
* Salmonellas

Microbial Trojan horses



Poultry as source of pathogens

Tempex beetles as vector (Hazeleger et al 2008)

- beetles infected and eaten by poultry
- droppings investigated
- chickens often colonised within 5 days

Alphitobius diaperinus
(darkling beetle)

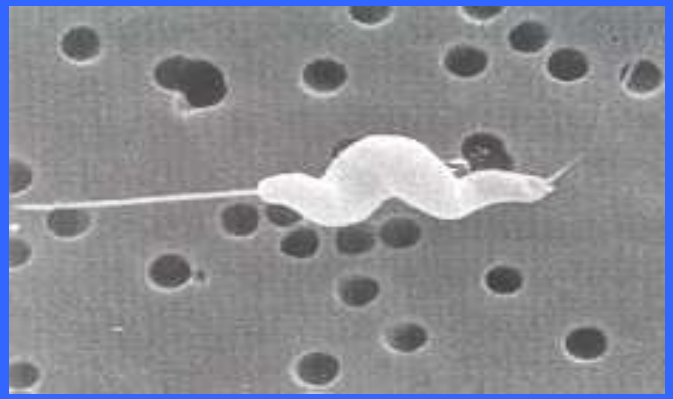
And how about the eggs?

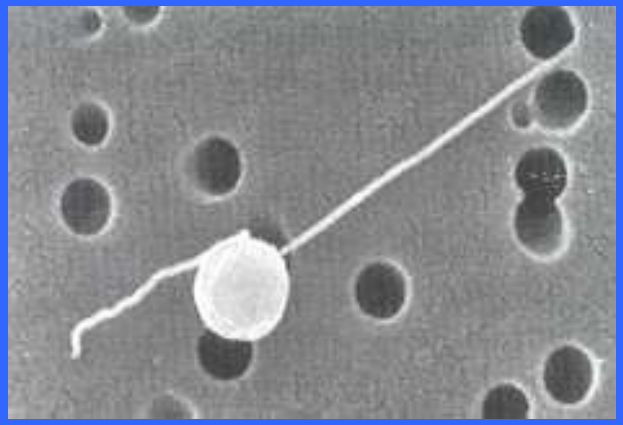
Campylobacter

* food infection, dose response 100-500 cells
* Guillain-Barré syndrome, reactive arthritis

Campylobacter

* spiral → coccus (non culturable, non-infective)





* growth at T>30° C
* sensitive to low Aw, freezing, O_2, room temp.
* micro-aerophilic (5-7% O_2)
* poultry, birds, water, raw milk

Campylobacter in water

* waste water poultry slaughterhouse up to

  Log 7 cfu/100 ml

* non-treated sewage up to Log 3 cfu/100 ml,

  after treatment: 1 log reduction, and

  after oxidation bed: 0.6 log reduction

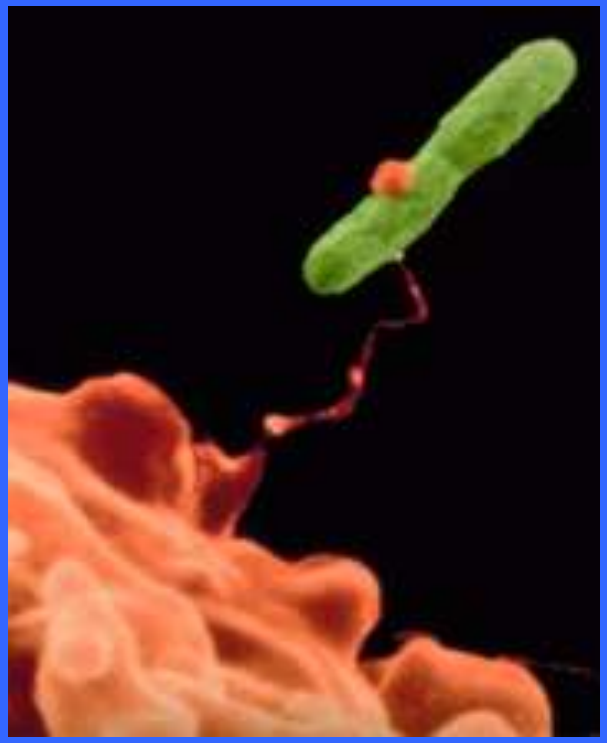
Campylobacter in water

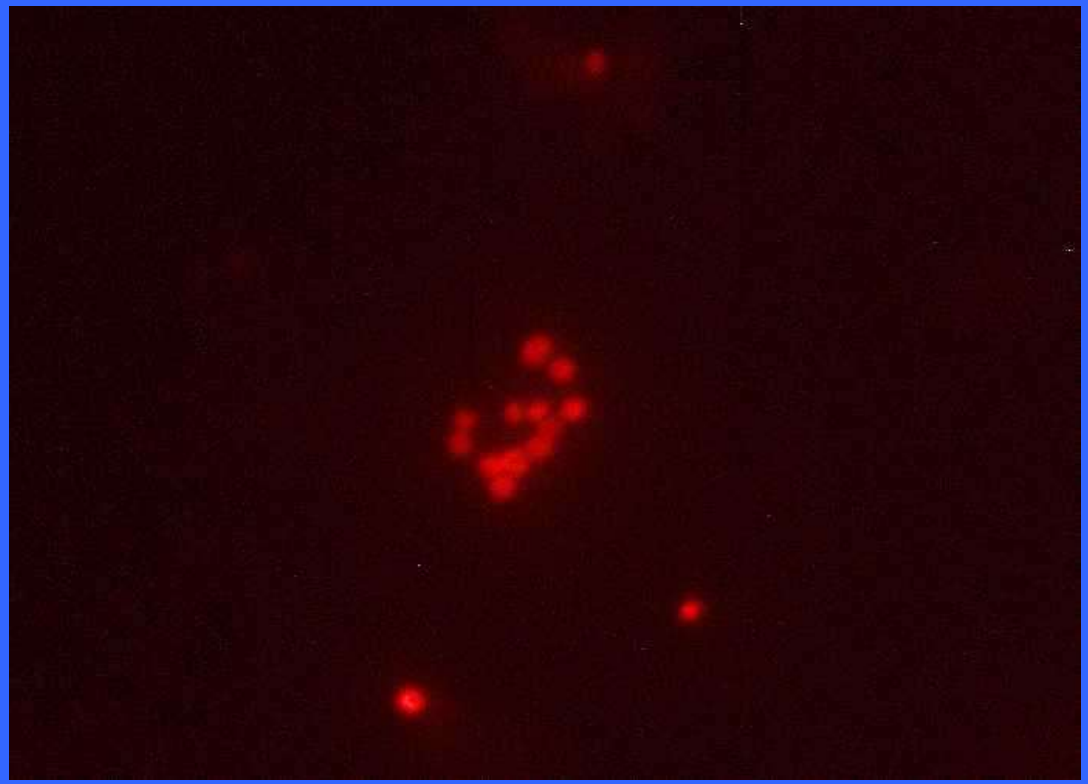
* effluent water 30 - 15.000 cfu/100 ml

Campylobacter in faeces and manure

* chicken faeces: Log 4 -9 cfu/g, after correct composting (T>70°C): <10 kve/g
* bird droppings and faeces from other animals: incidental and local
* incidentally in raw vegetables, probably no long survival

Remember microbial Trojan horses





Escherichia coli O157

* Shigatoxinproducing *E. coli* (STEC)
* Acid-resistent: low dose response
* complication: haemolytic uremic syndrome (HUS) in 30-50% fatal

Escherichia coli O157

* not only cattle
* also pigs, goats and sheep
* and all the products contaminated by the faeces of these animals

E. coli O157

Cause disease

* contact with animals
* consumption of raw or undercooked meat:
  * hamburger, raw milk, raw milk cheese

Survival beef products

* 'filet americain', refrigerator: > 7 days
* fermented sausages: several weeks
* minced beef in freezer: several months

Define realistic criteria …

USDA zero tolerance for *E. coli* O157 in ground beef … better inform consumers

E. coli O157 childrens farm

Hygiene code

E. coli O157 childrens farm

Cow cuddling

Prevention *E. coli* O157 in animals

* prevention of infection:

  how, not clear

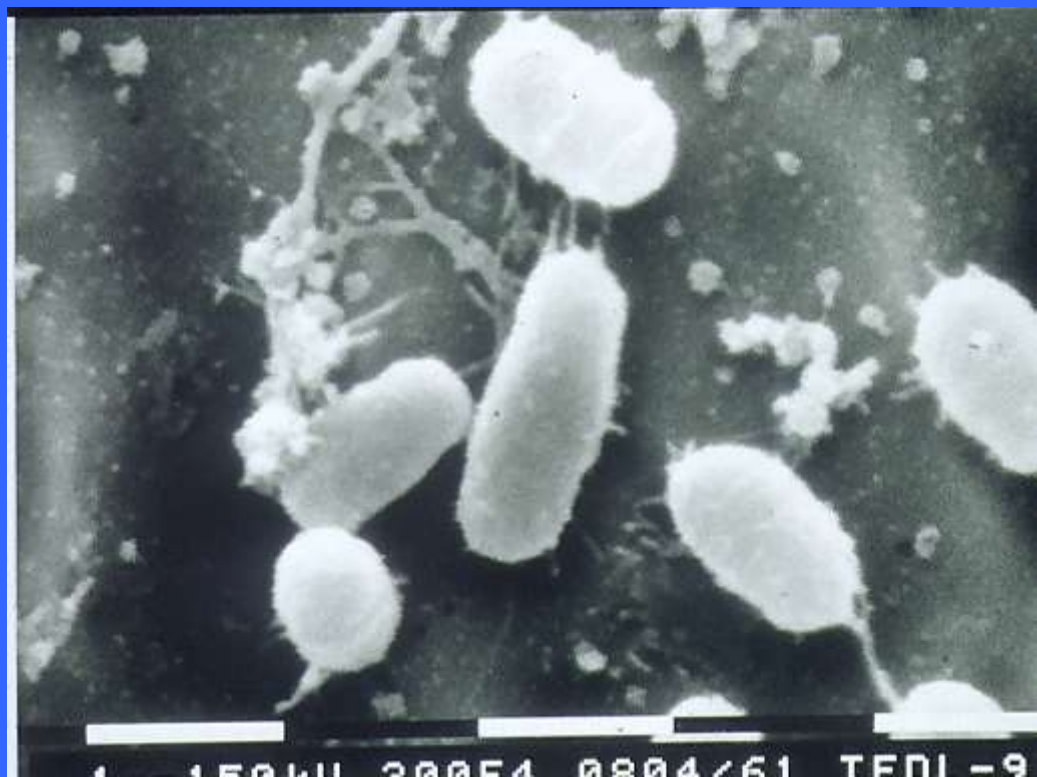
* check animals at arrival:

  no sense, intermittant excretion

* treatment/removal positive animals

  not an option, intermittant excretion

Listeria monocytogenes



Listeria monocytogenes

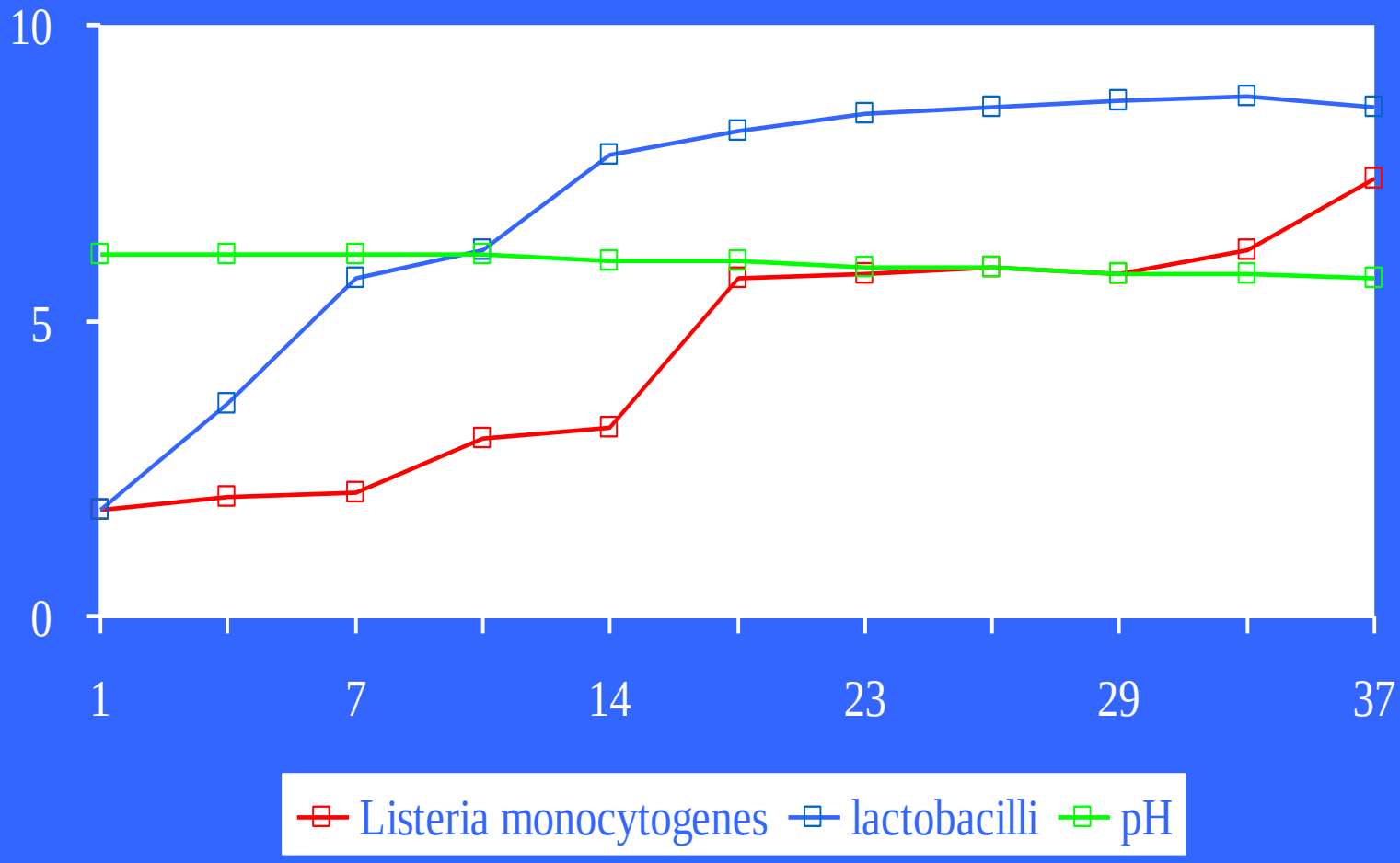
* Environment
* Apparatus
* Vegetables
* Raw milk, cheese
* Meat and
* (cooked) meat products
* (smoked) fish

Contamination during and after cutting

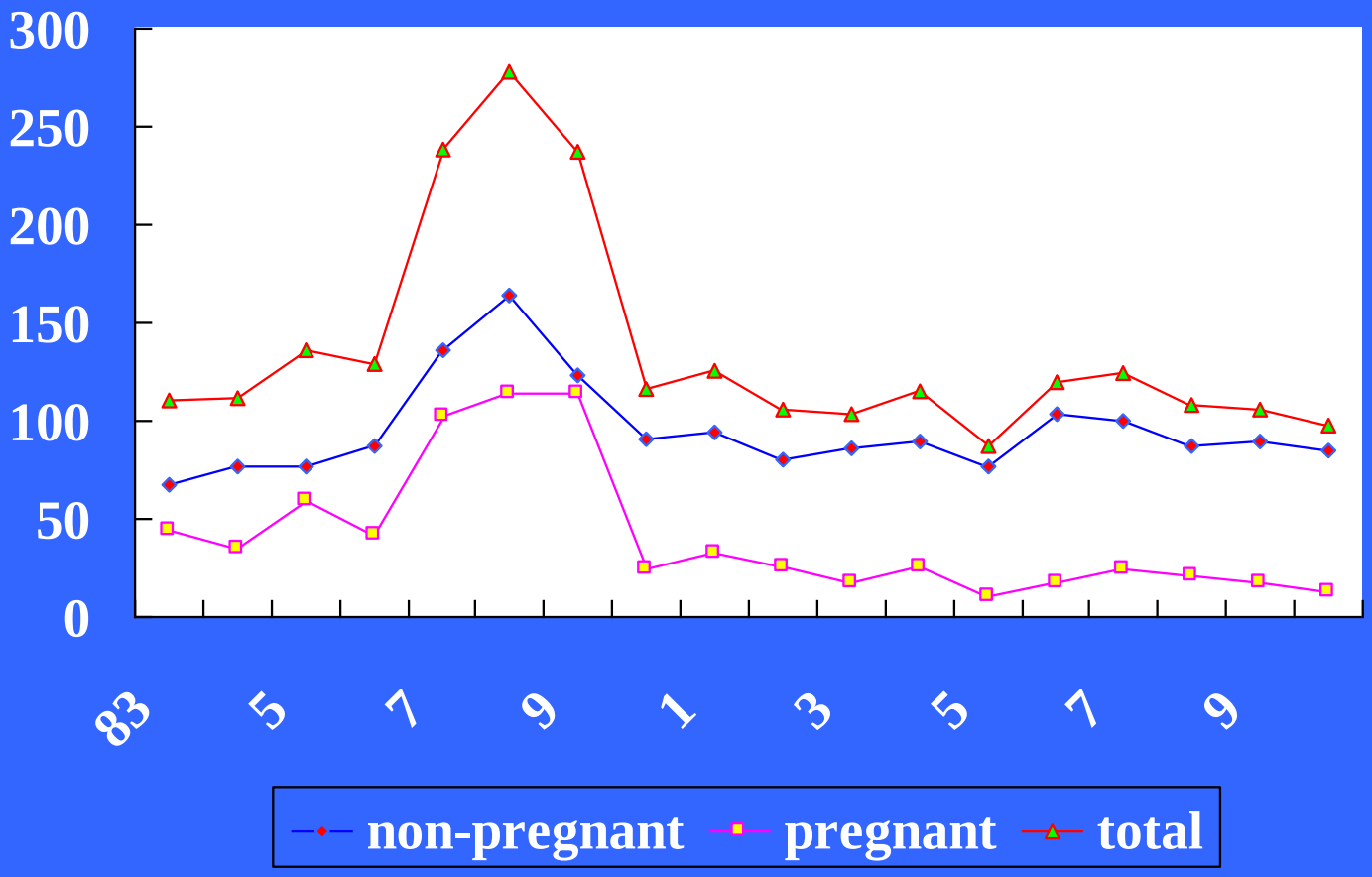
Via

* wet spots
* trolleys
* apparatus

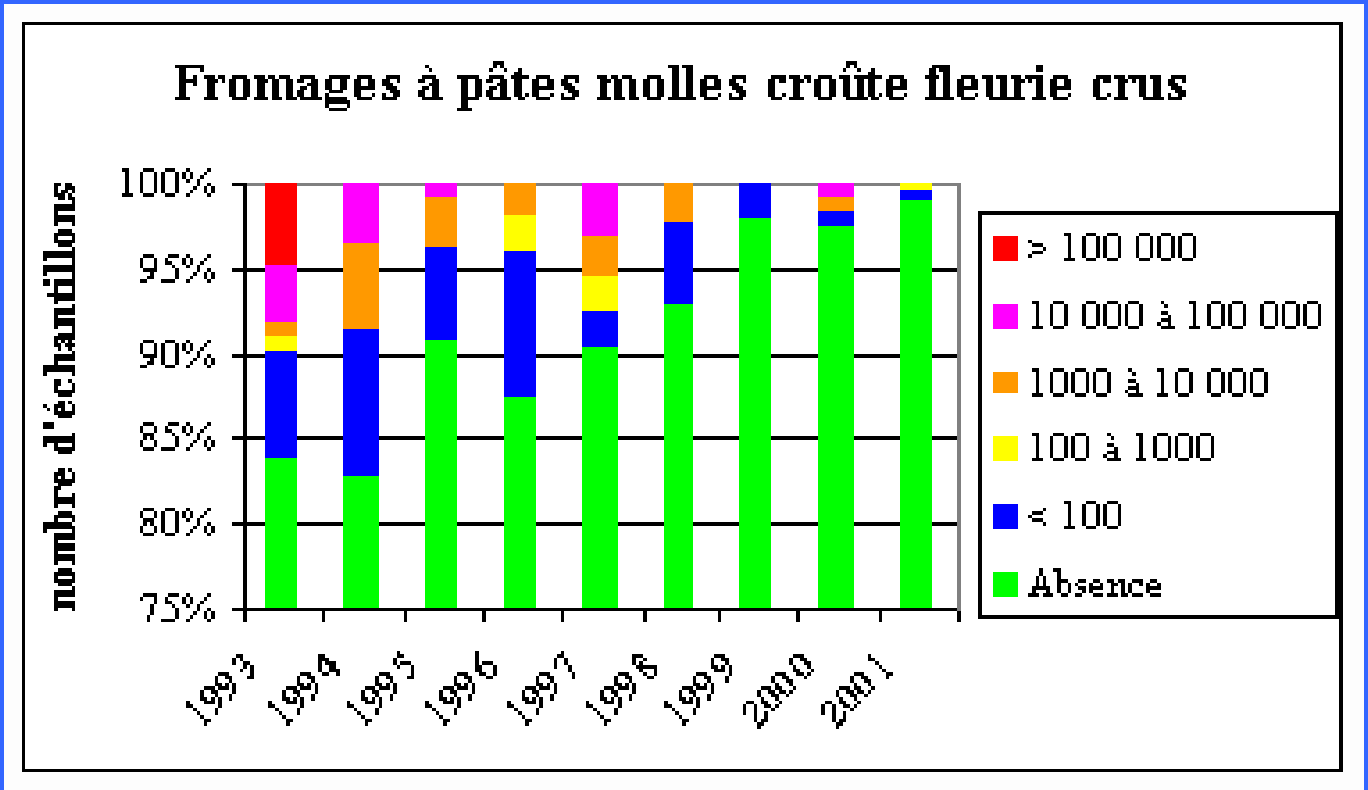
Growth of *Listeria monocytogenes* and lactic acid bacteria on luncheon meat at 7°C



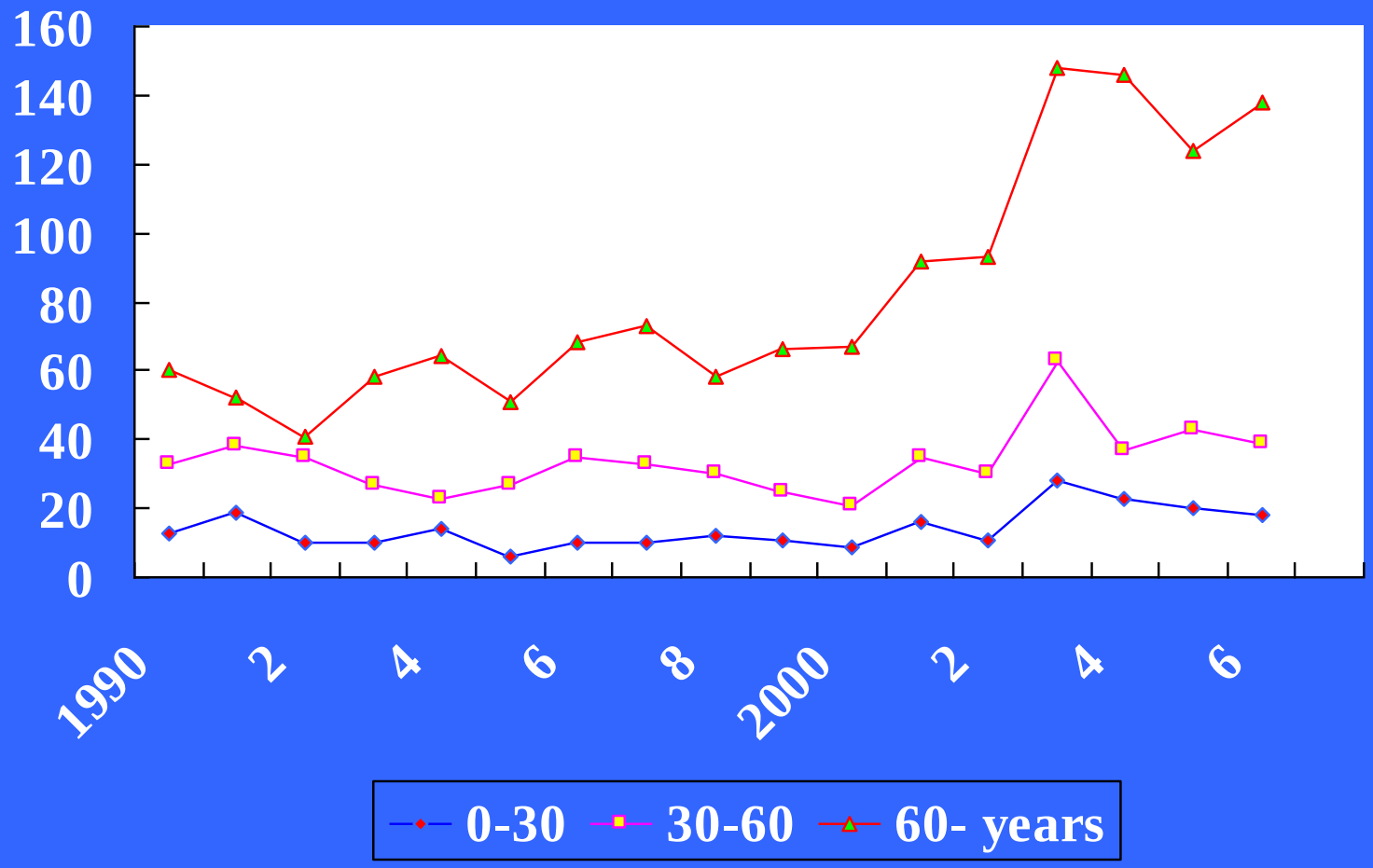
Listeriosis: cases UK 1983-2000 (PHLS)



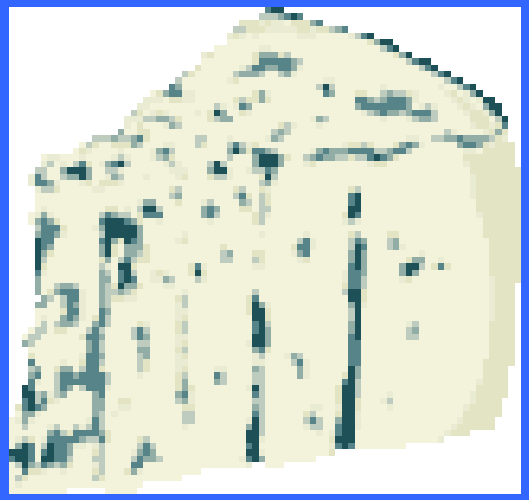
Contaminated cheeses in France

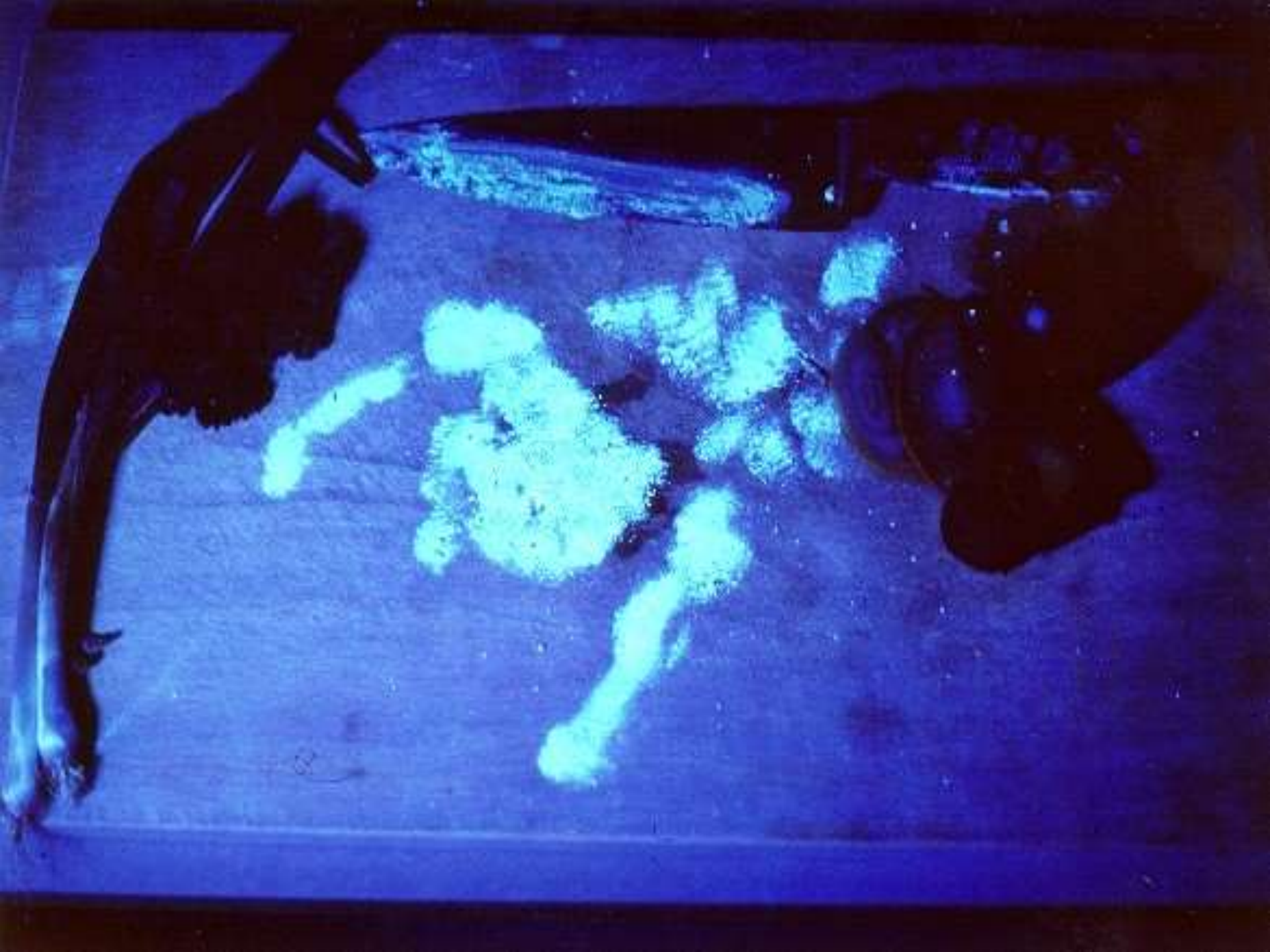


Listeriosis: cases (UK) 1990-2006

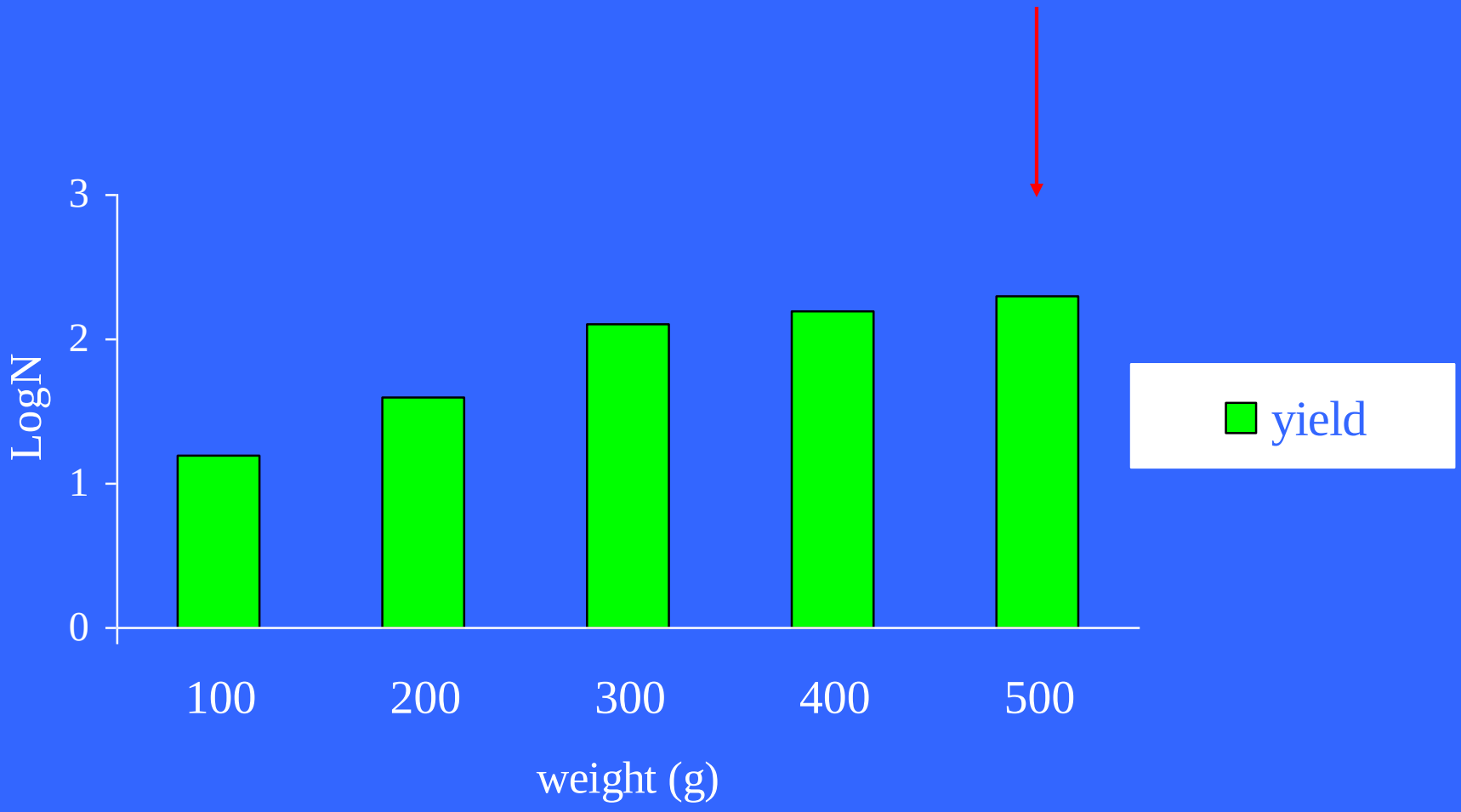


That what you bring home may hurt you …

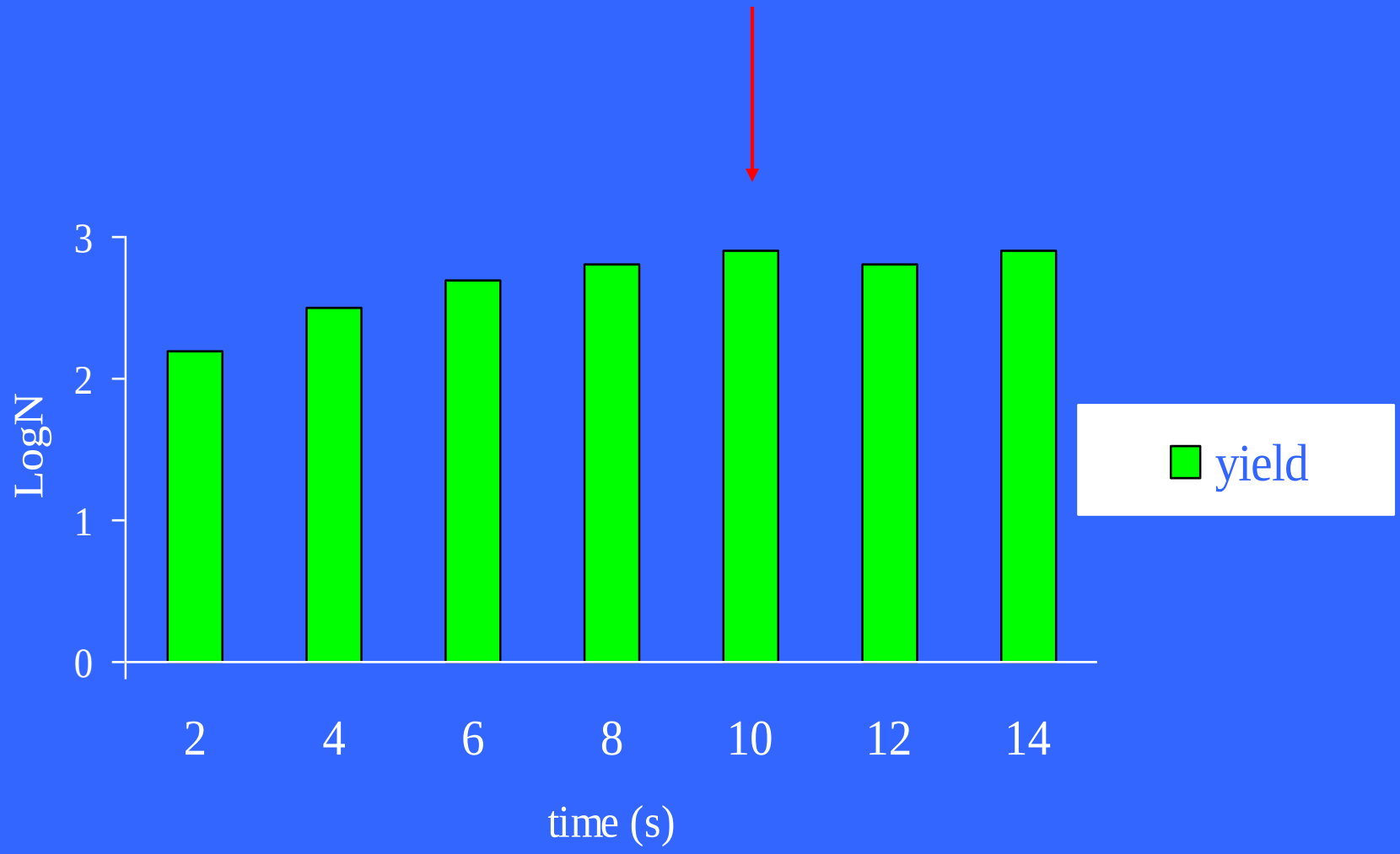




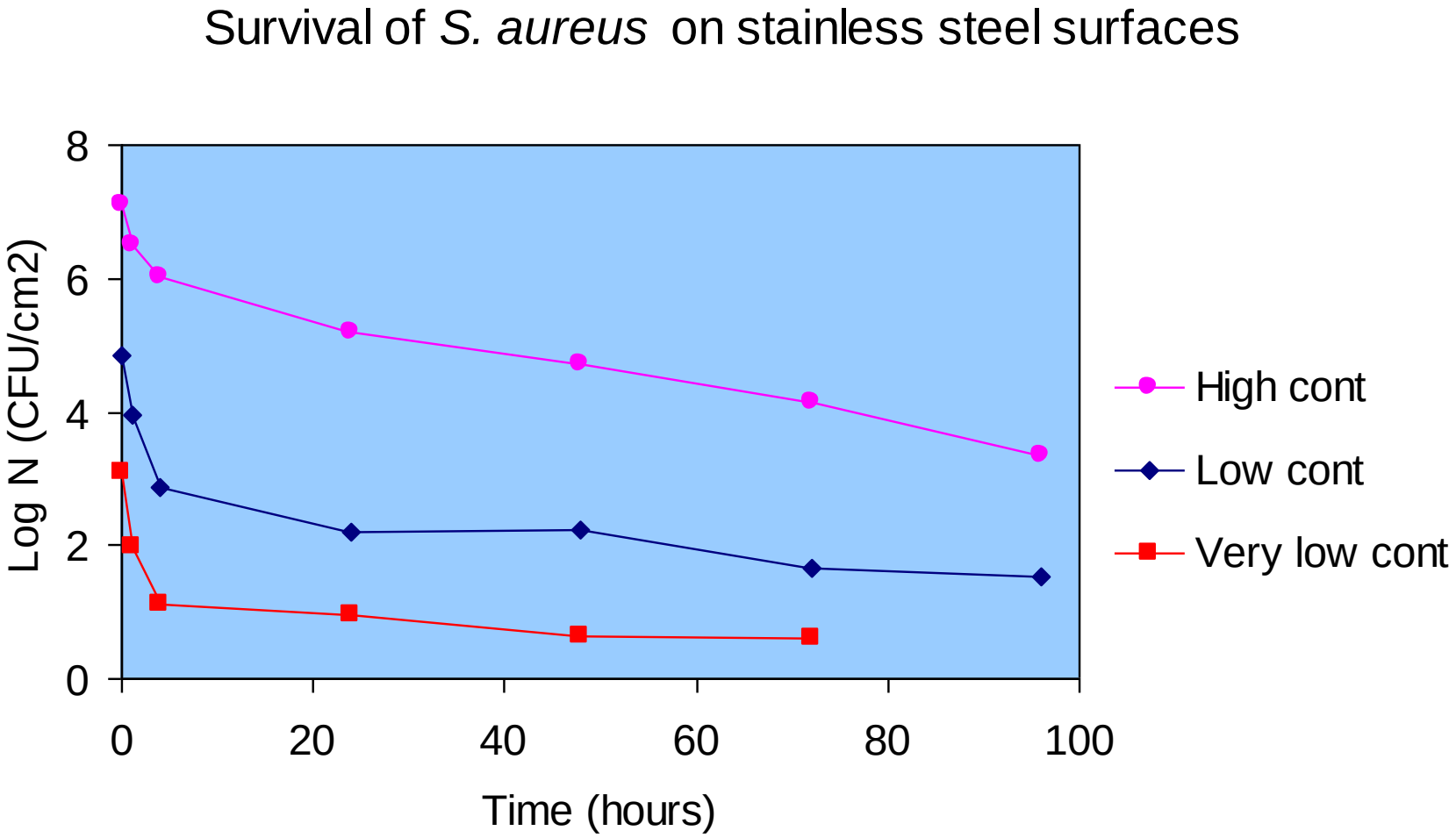
Effect of pressure



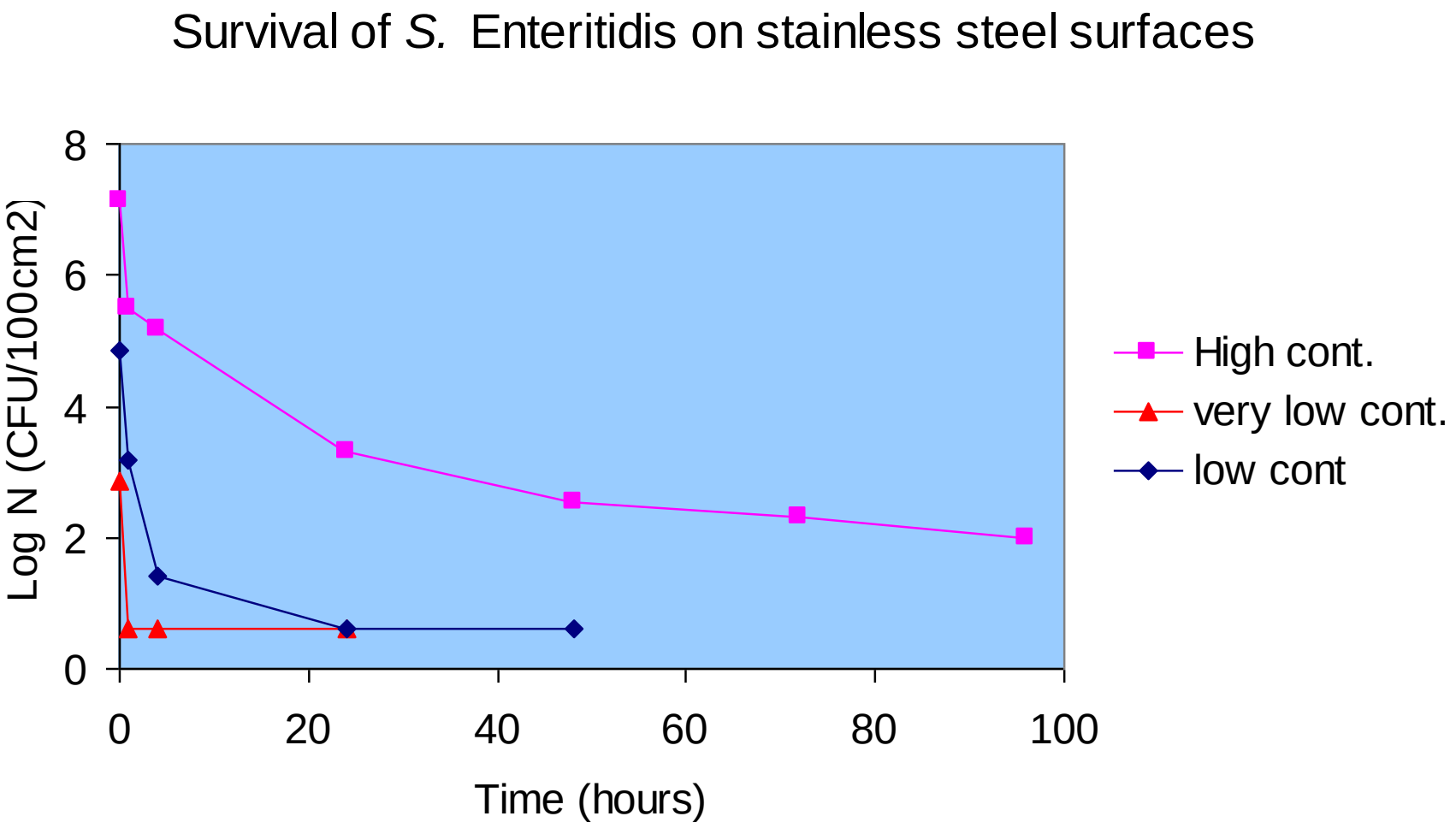
Effect of time



Survival of pathogens (1)



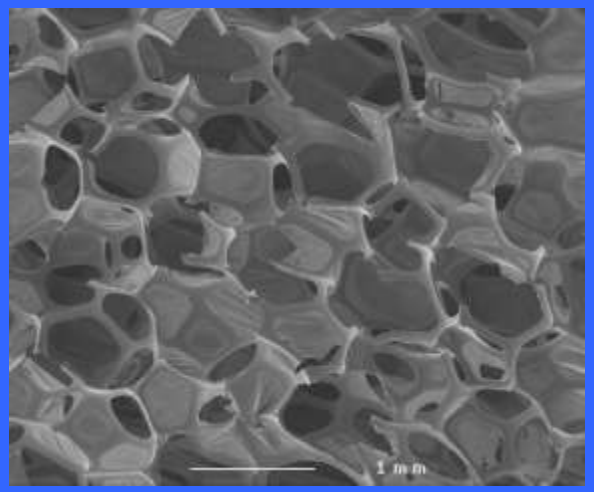
Survival of pathogens (2)

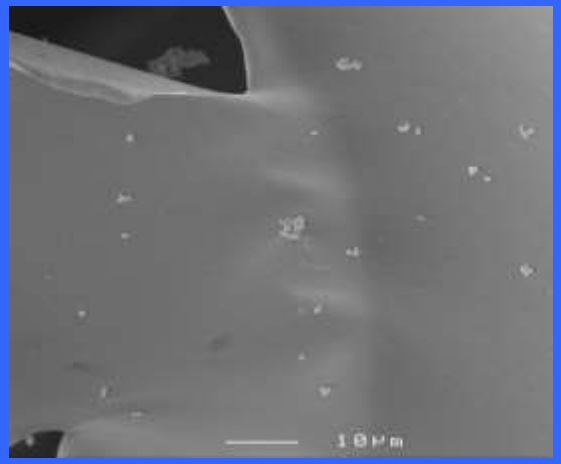


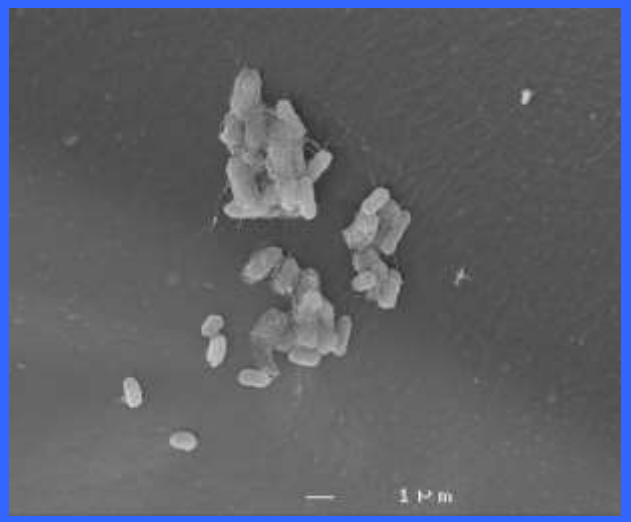
Sponges with antibacterial detergents

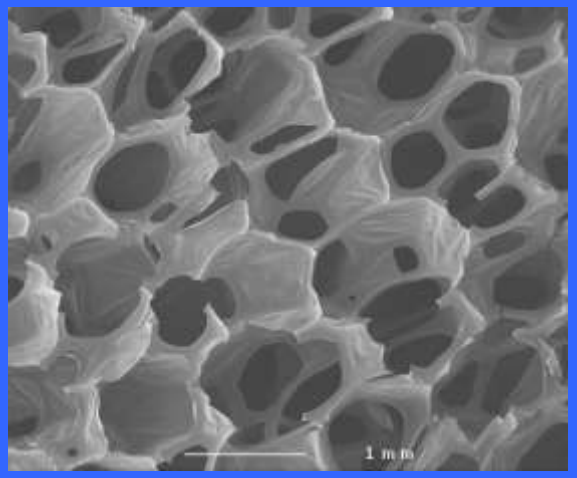
Fairy or fairytales?

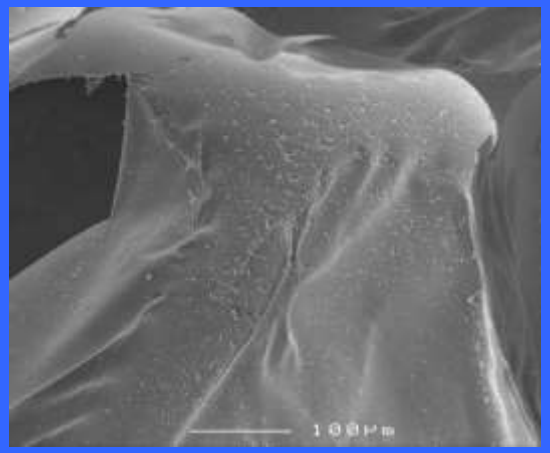
An important reason is the presence of dirt …

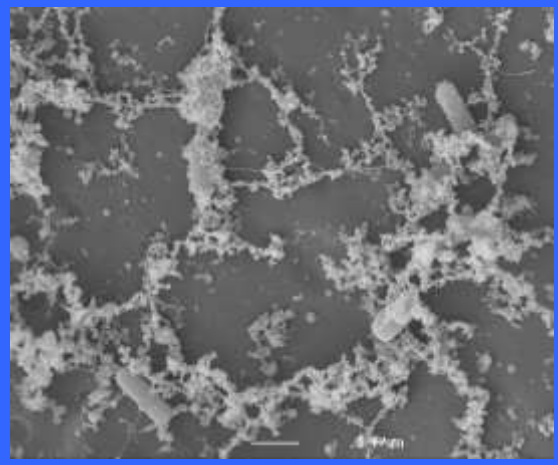












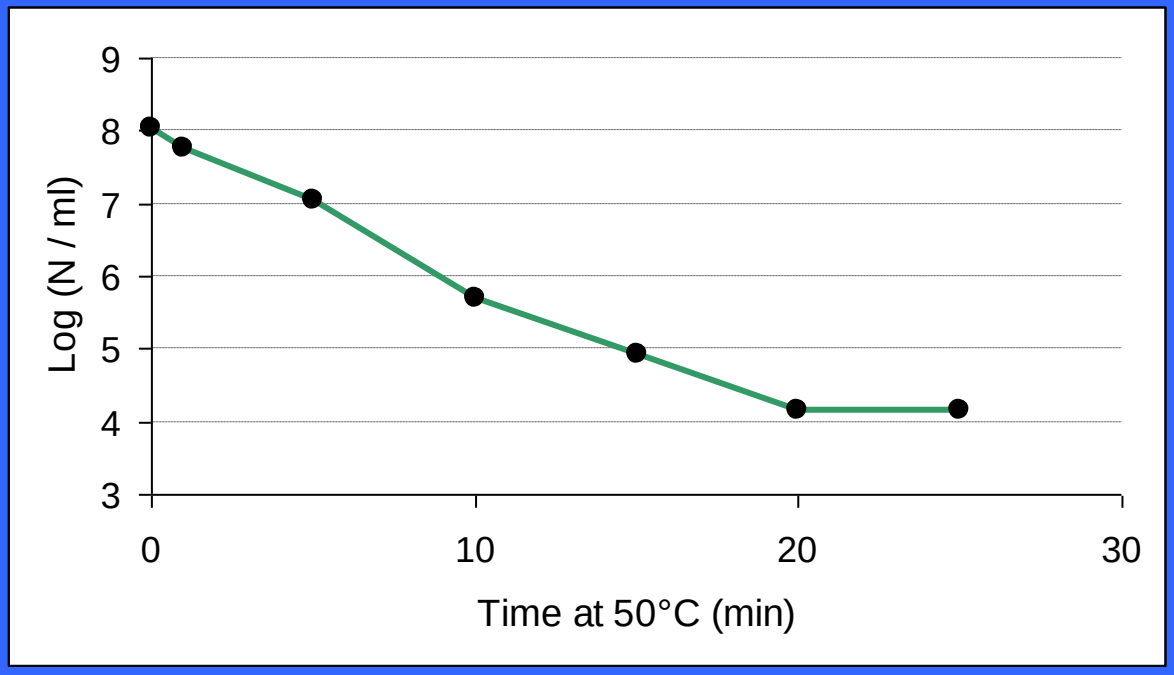
Stress in bacteria

Low pH, high temperature, low a_w, antibiotics, reactive oxygen, starvation, preserving, disinfecting', conserveren, desinfecting

Was mich nicht umbringt, macht mich stärker (Friedrich Nietzsche)

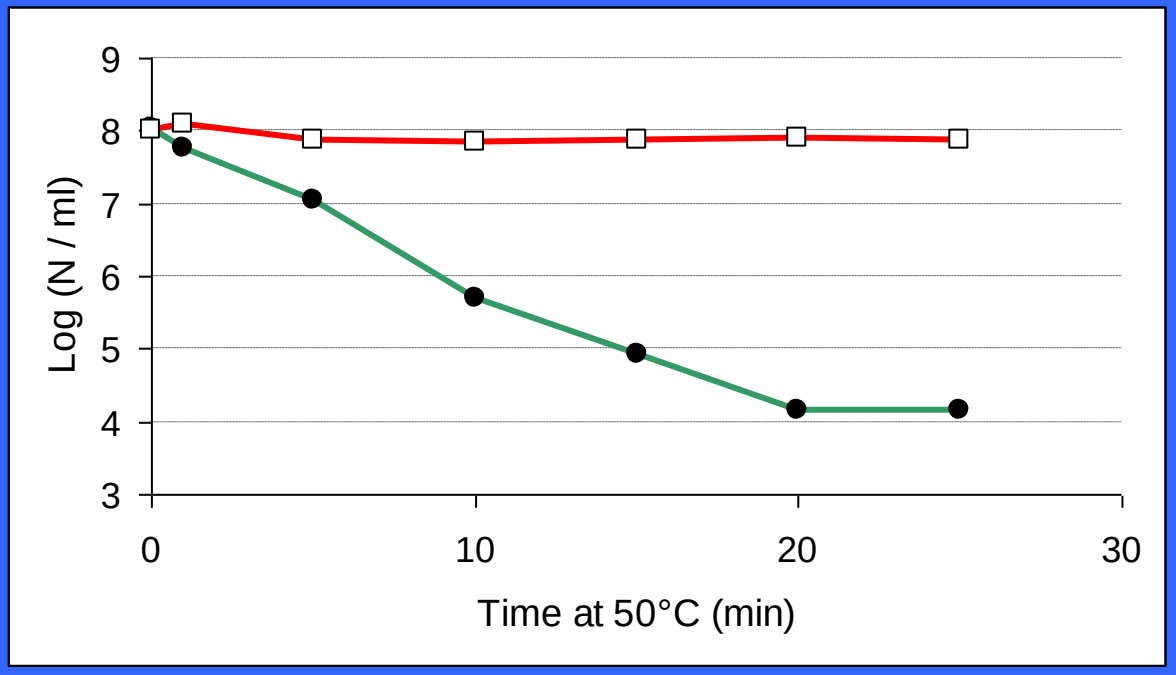
Protective effect of stress-response

Culture grown overnight at 30ºC ⇒ thereafter at 50ºC



Protective effect of stress response

Culture overnight grown at 30ºC ⇒ 30 min. at 42°C ⇒ thereafter at 50ºC



Conclusions for food producers

* Raw products, which are contaminated with pathogens will remain a hazard, even when the food is held at low temperatures (refrigerator or freezer)
* Heat treatment (temperature up to 70°C, or higher) will inactivate pathogens, usually not spores
* Most other methods only decrease mo in numbers
* Be aware of stress in mo
* Clean and disinfect thoroughly
* Be careful in case of a long shelf life

Conclusions for consumers

for the safety of foods, which enter kitchens as raw agricultural commodities, including meat, poultry, seafood and vegetables, one cannot rely solely on animal health programs and sanitation

A certain knowledge is necessary to prepare food as safe as possible for family and quests