

Water microbiology

Beware of the little things!

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Specialist Science Solutions

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protecting people and their environment through science

Introduction

- **Why important?**

- Global disease burden
 - 4.1% total daily global burden of disease
 - 1.8 million deaths per year
 - 88% attributed to unsafe water / poor sanitation

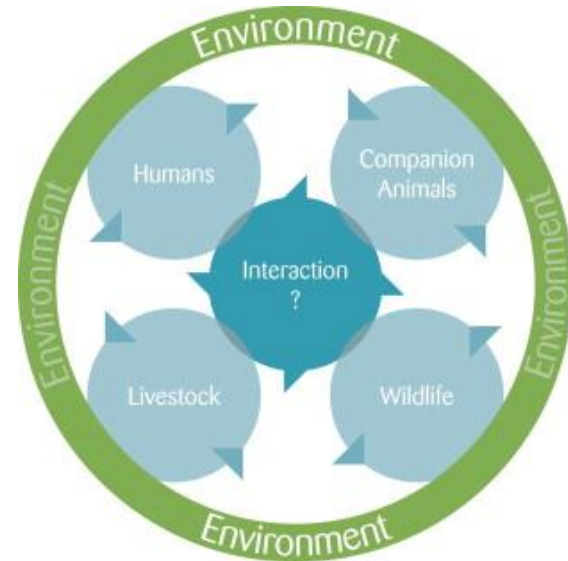
Pond, K. Water Recreation and Disease. Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality. London, UK: World Health Organisation; 2005.

- **Where are they coming from?**

- Numerous sources
 - Faecal matter – human and animals
 - Environmental
 - Transport to water bodies

- **Important factors**

- Survival
- Shedding rates
- Infective dose
- Virulence



New Zealand 2012 Notified Diseases

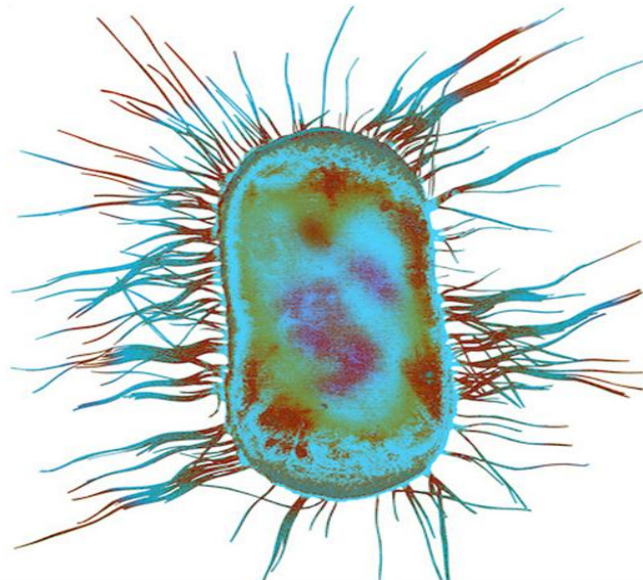
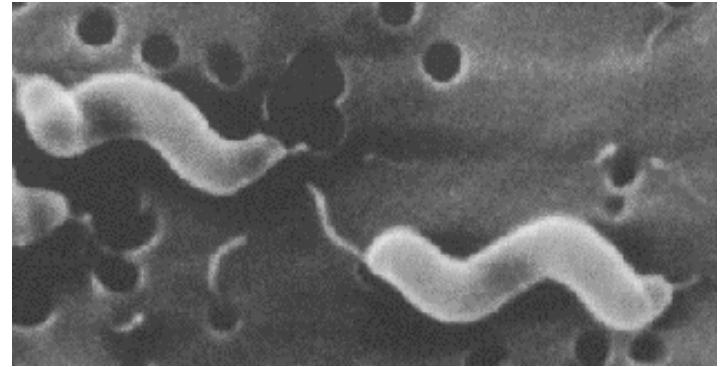
Disease	Cases	Rate/ 100,000	Contact farm animals	Recreational water contact	Overseas travel
STEC	130	3.0	59%	30%	3%
Cryptosporidiosis	954	19.4	55%	40%	9%
Campylobacteriosis	7346	166	39%	11%	6%
Salmonellosis	1146	23.9	38%	14%	20%
Yersiniosis	455	11.9	35%	10%	4%
Giardiasis	1785	39.3	31%	31%	21%
Shigellosis	105	2.4	11%	28%	66%

Waterborne outbreaks in NZ 2012

- 51 Outbreaks resulting in 379 cases
- Pathogen
 - *Giardia* 65 cases – 19 outbreaks
 - *Cryptosporidium* 64 cases – 19 outbreaks
 - Enteric bacteria (*Campylobacter*, *Salmonella*, *Yersinia*)
206 cases – 13 outbreaks
 - Norovirus 53 cases – 1 outbreak
- Source of waterborne outbreaks
 - Untreated drinking water 72.5% (37/51)
 - Inadequately treated water supply 29.4% (15/51)

Micro-organisms in animal poo

- *Campylobacter*
- *Salmonella*
- *Cryptosporidium*
- *Giardia*
- *E. coli* O157



Carriage of *Campylobacter* in dairy faeces

- Meanger & Marshall (1989)
 - 12-24% of cows
- Savill et al. (2001)
 - 51% cows, 65% of calves
- Adhikari et al. (2004)
 - 54% of Friesian cows
- Gilpin et al. (2005)
 - 66% of cows
- Moriarty et al. (2007)
 - 64% of cows



Lamb poo (105 samples)

- ***Campylobacter***

- 81% samples positive
- 1 – 4,600,000 cfu/g

- ***Cryptosporidium* spp.**

- 37% samples positive
- 1 – 73,882 oocysts/g

- ***Giardia* spp.**

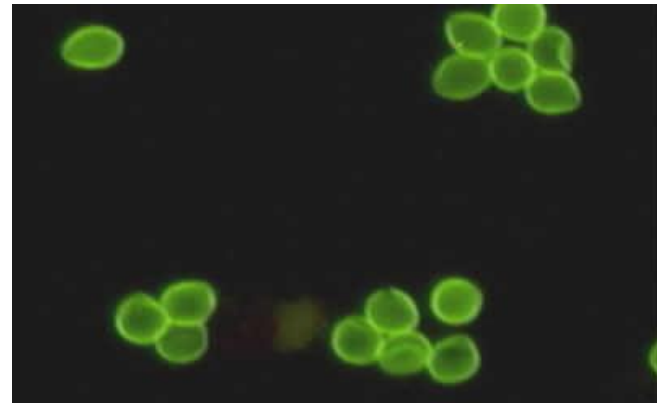
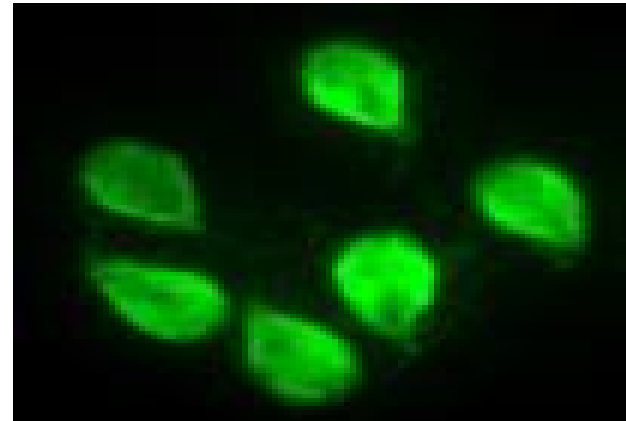
- 28% samples positive
- 1 – 733 cysts/g

- **STEC**

- 3.8% positive

- ***Salmonella***

- 1.9% positive



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Survival in the Environment

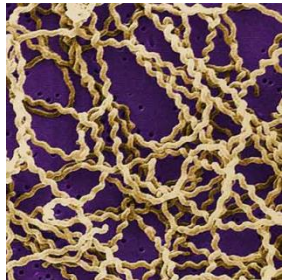


Others worth a mention

- *Yersinia*
 - Gastrointestinal illness
 - Reservoir pigs, water bodies
- *Legionella*
 - Legionnaires disease, pontiac fever
 - Survival and growth in water (20 - 50°C)
 - Airborne
 - Low infective dose – may be as low as 1 cell
- *Leptospira*
 - Leptospirosis
 - Animal urine
 - Transmission in water
- More.....



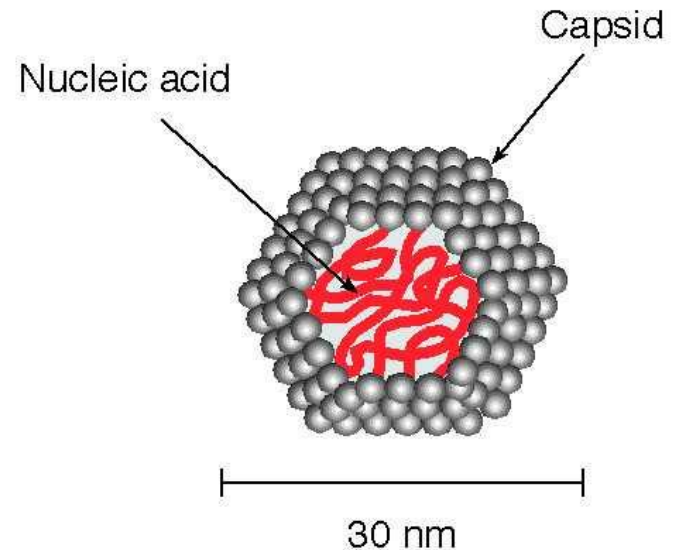
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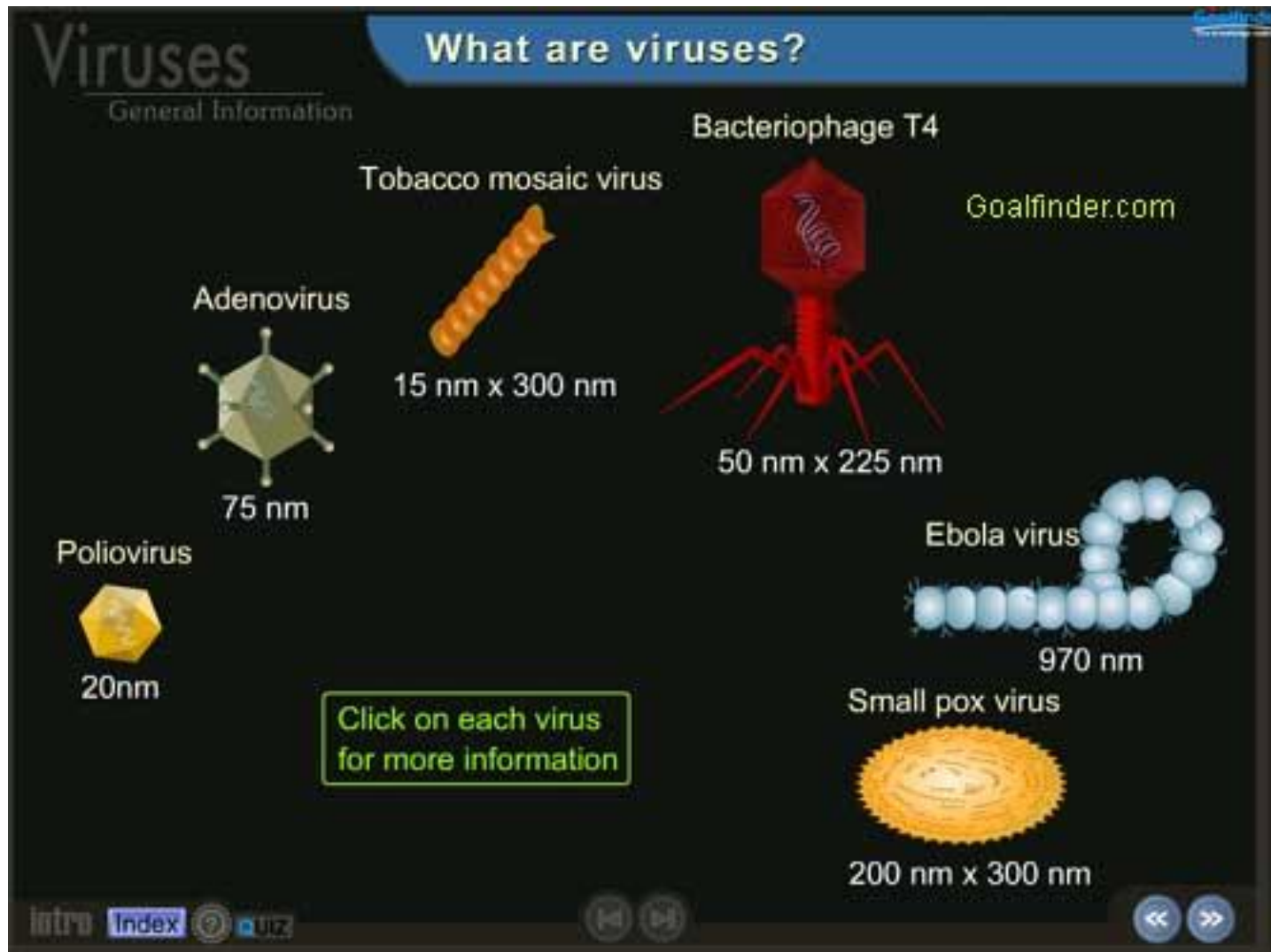
Survival in the Environment

Viruses

- **Two types:**
 - DNA
 - RNA
- **Many viruses in each type**
- **Very small**
- **Resistant & long lived**
- **High numbers excreted**
- **Infective dose can be very low – 1 virus particle**
- **High virulence**

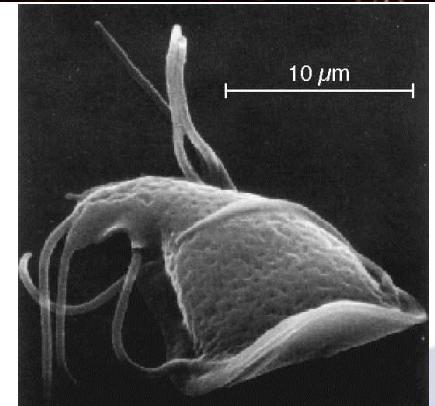
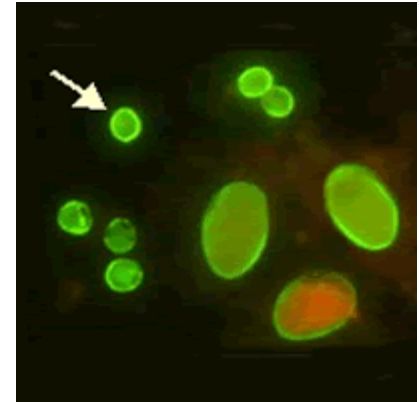


Examples of viruses



Protozoa

- Survive very long periods in the environment (potentially years)
- Organism protected in a hard 'shell'
- *Cryptosporidium* (4 – 6 μm diam.)
 - Low infective dose <100 oocysts
 - No effective treatment
 - Life threatening
 - High numbers shed
- *Giardia* (6 – 10 μm elliptical)
 - Ubiquitous in the environment
 - Prolonged illness
 - High numbers shed, some asymptomatic



Indicator organisms

- Pathogens are the ones that cause disease
- Not always present and there are many different pathogens
- Many pathogens are difficult to detect although there is a lot of progress using molecular biology techniques
- Indicators are used that indicate the presence of faecal contamination and thus the possible presence of pathogens

Considerations for use of indicator organisms

- Indicators should be :
 - consistently present in faecal material
 - present in high numbers
 - similar to pathogens in survival and transport
 - easily quantifiable
- Coliform bacteria – *E. coli*
- Enterococci - marine waters
- Viruses - Bacteriophages

Sampling and analysis considerations

- **Problem: needle in a haystack**
- **Need to detect microscopic organisms in large volumes**

- **Sampling**

- **Aseptic techniques**
 - **Sterile containers**
 - **Gloves**
 - **Sterility wipes**
- **Keep samples in the dark and chilled (not frozen)**
 - **Chilly bins with ice packs**

- **Analysis**

- **Normally within 6 hours for bacteria**
- **24 hours other organisms**

- **Methodology steps**

Concentration → Separation → Identification → Enumeration

Examples of our work



Survival of indicator organisms in
Canadian geese droppings



- Transport of indicator organisms from cowpats to vadose zone



- Transport of indicators and pathogens through aquifer media



- **Faecal source tracking**
- **Identify sources of contamination in environmental samples**
 - Human
 - Bovine
 - Cervine
 - Wildfowl
 - Possum?

Conclusions

Important factors:

1. Survival

Can be prolonged in the environment (months, years)

In high numbers, high excretion rates

2. Infective dose

Quite high in bacterial infections in general

Can be low e.g. *Cryptosporidium* 10-100 oocysts, viruses 1 particle

3. Virulence

Highly infectious and transmission routes can vary e.g. waterborne transmission, faecal-oral route