


Friend or Foe?
Bacterial Viruses in Food Production

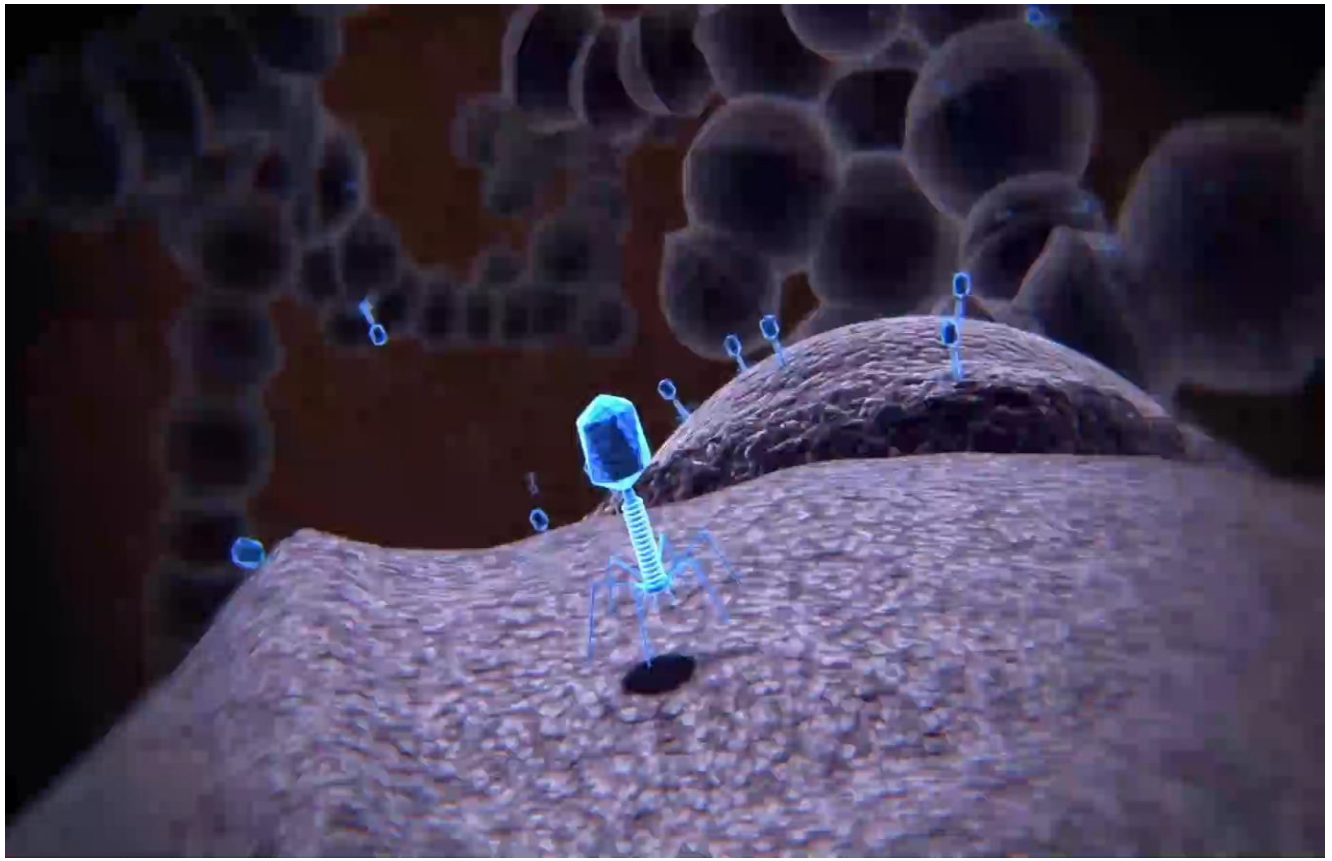
Olivia McAuliffe Ph.D.
Principal Scientist
Teagasc Food Research Centre, Moorepark, Fermoy, Cork.

Teagasc
Agriculture and Food Development Authority

TEAGASC RESEARCH INSIGHTS
LEADING RESEARCH FOR TOMORROW'S AGRI-FOOD SYSTEMS

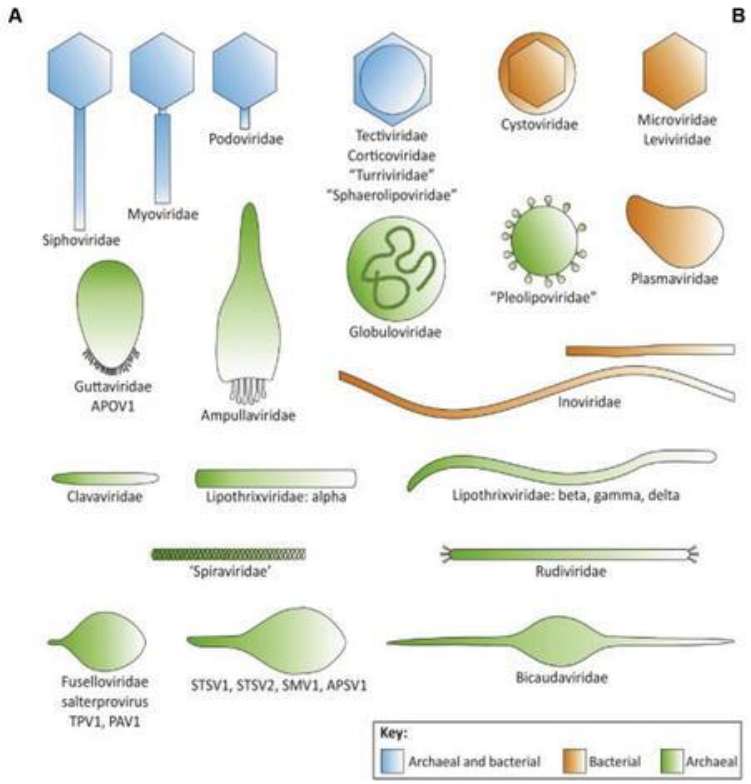
What are ‘Bacteriophages’?

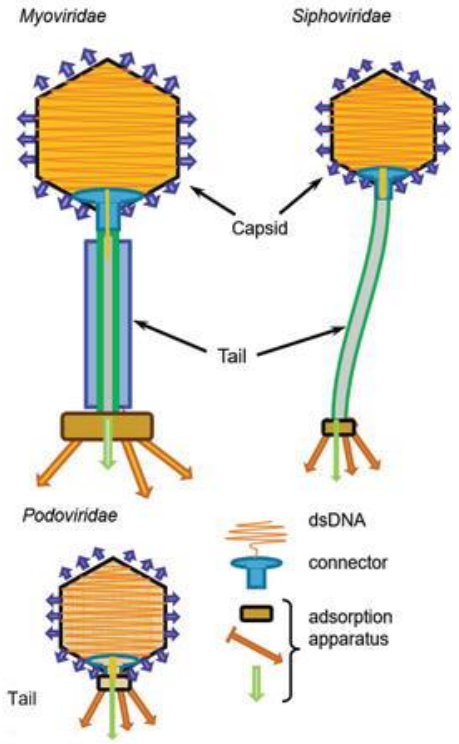
- Bacteriophages, or phages, are bacterial viruses.
- Natural viral predators of bacteria, found in every ecosystem on the planet.
- Most abundant biological entities in the biosphere (~10^{31}).
- Specifically infect bacteria only and are completely harmless to humans/animals.



What do phages look like?

Phage Morphology





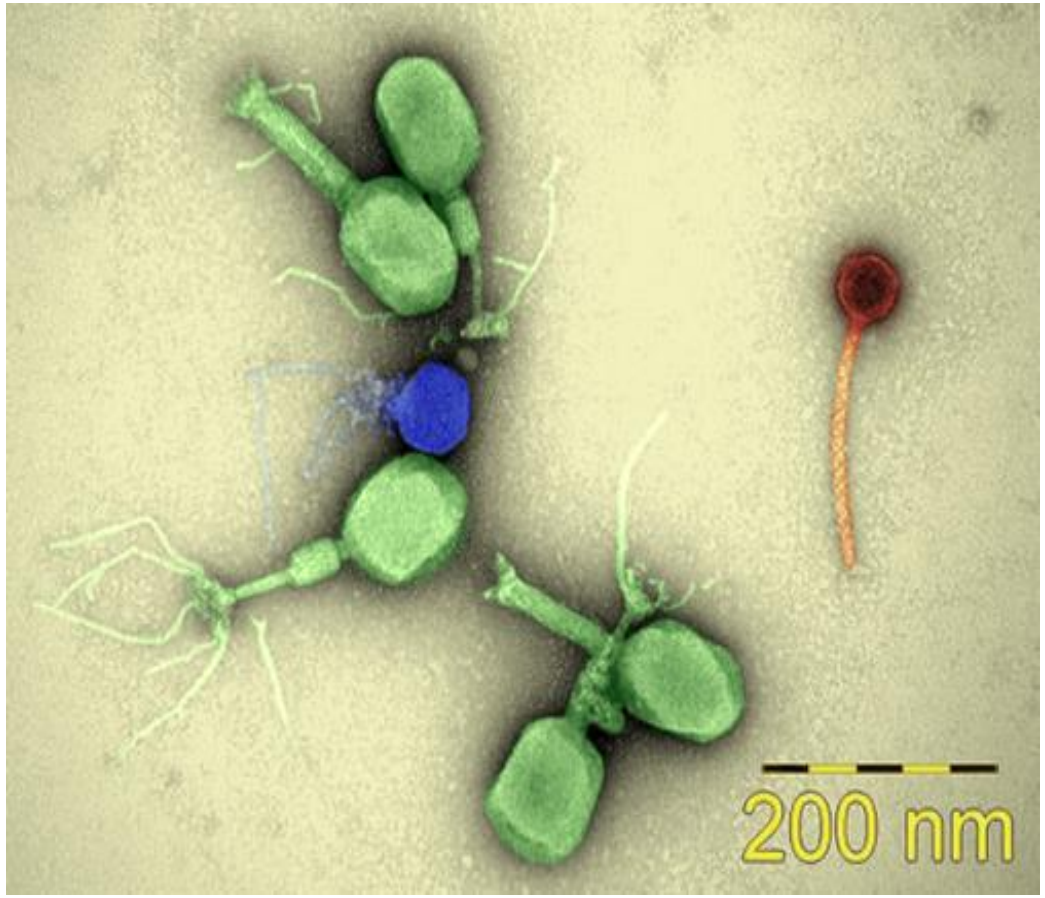
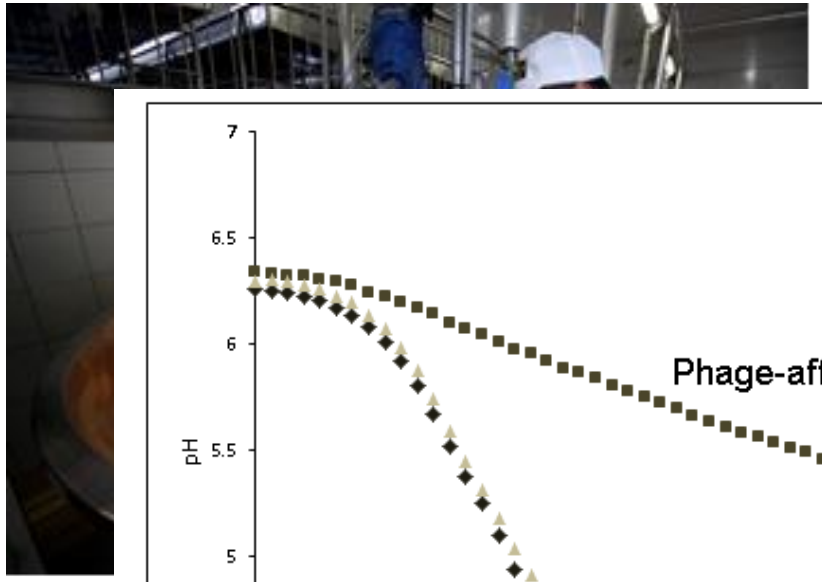


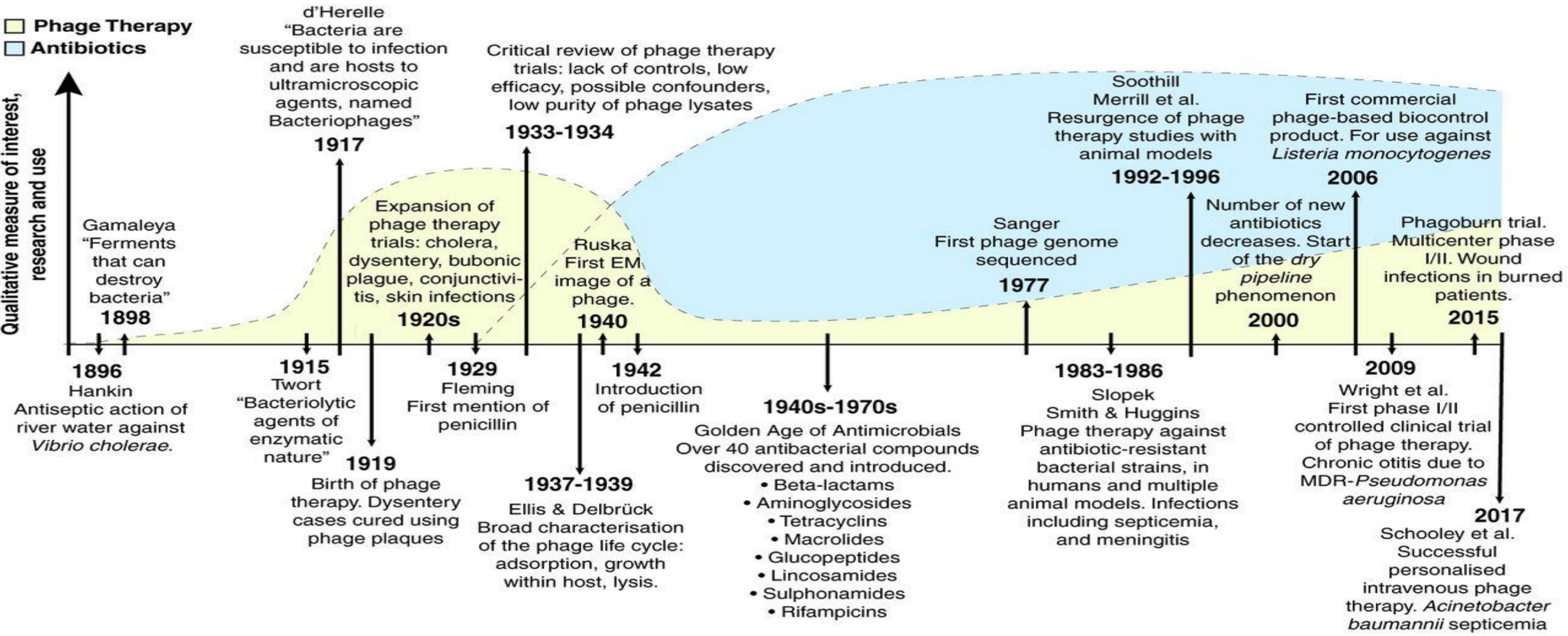
Image - Prof Horst Neve, MRI Institute, Kiel, Germany

The battle against bacteriophages in the dairy industry….

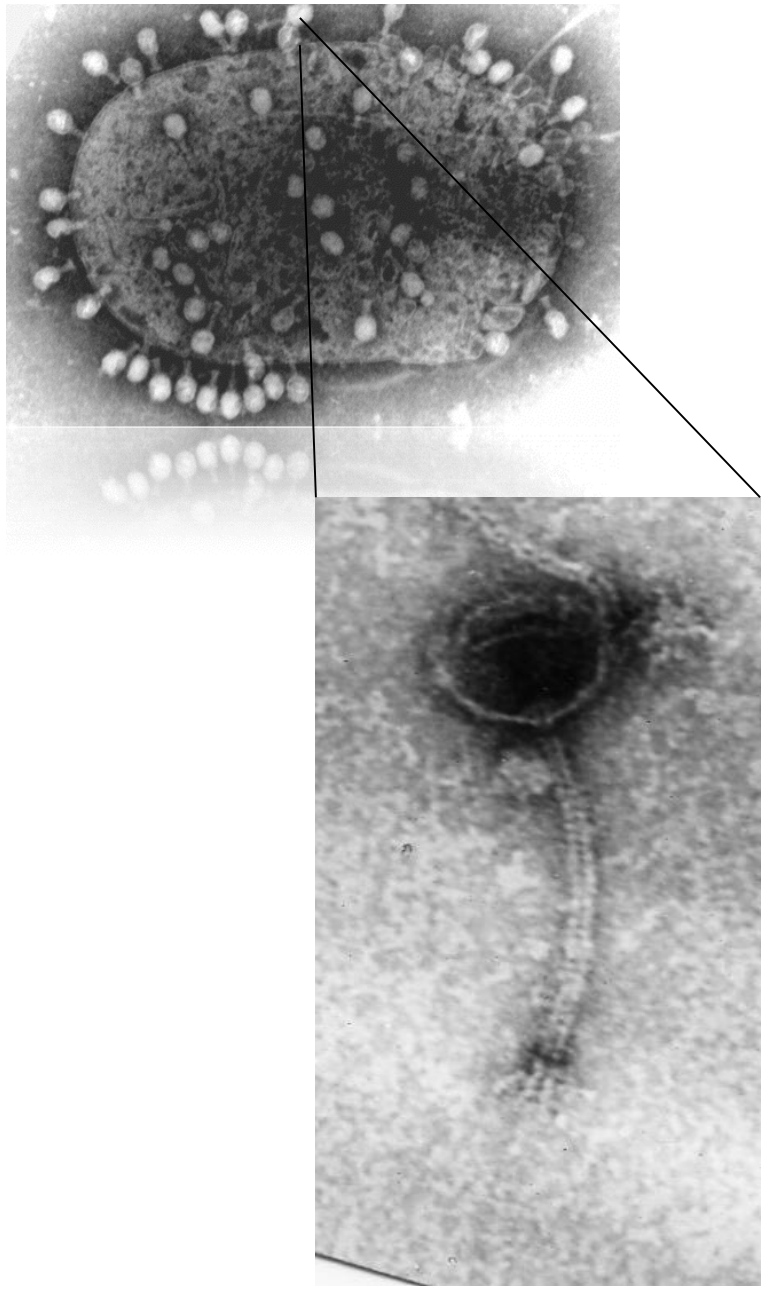
- Phages can be major problem in the dairy industry.
- Large volumes of bacterial cultures are grown to produce cheese, yogurt, and other fermented dairy products.
- Phages in a dairy processing plant can lead to major economic losses.



Phages as Therapeutics….a centuries-old idea….



Phage as Control Agents in Food - Two Approaches



1. Whole Phages or ‘Phage Cocktails’

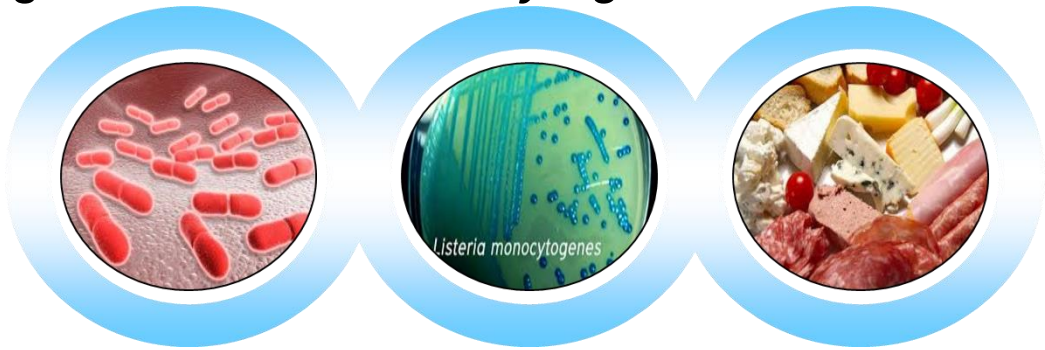
Use of a single phage, or multiple phages in a mixture known as a ‘phage cocktail’.

- Bacterial Target 1 - *E. coli* O157:H7

2. Phage Enzymes/Endolysins

Enzymes derived from phages which are used to lyse the host cell, can be used from the ‘outside-in’ also.

- Bacterial Target 2 - *Listeria monocytogenes*



Target 1: *Escherichia coli* O157:H7

- Causative agent of serious foodborne illness.
- Consumption of undercooked beef but food sources expanding.
- Cattle are the main reservoir, asymptomatic, erratic shedding.
- High % of antibiotic resistance in isolates from animals.

Target 1: *Escherichia coli* O157:H7

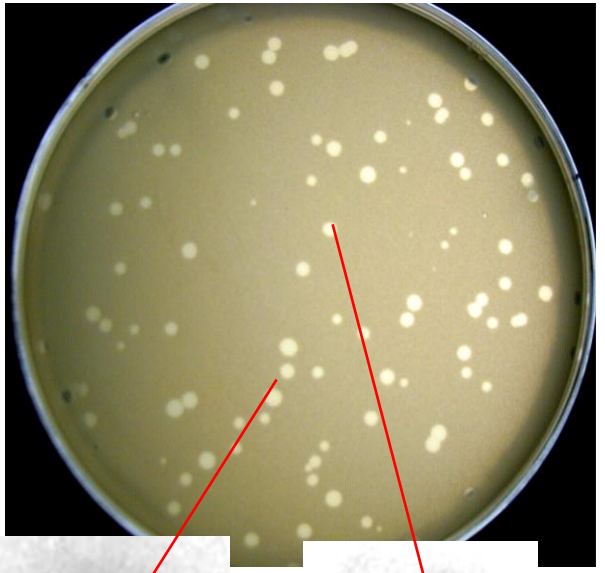
Phage Enrichment and Isolation

Samples of Bovine Slurry

+ *E. coli* target cells

Examine for Cell Lysis

Plaque assay with *E. coli* cells



e11/2

e4/1c

Active against all *E. coli* O157:H7 strains tested

Target 1: *Escherichia coli* O157:H7

In food systems, two types of intervention:

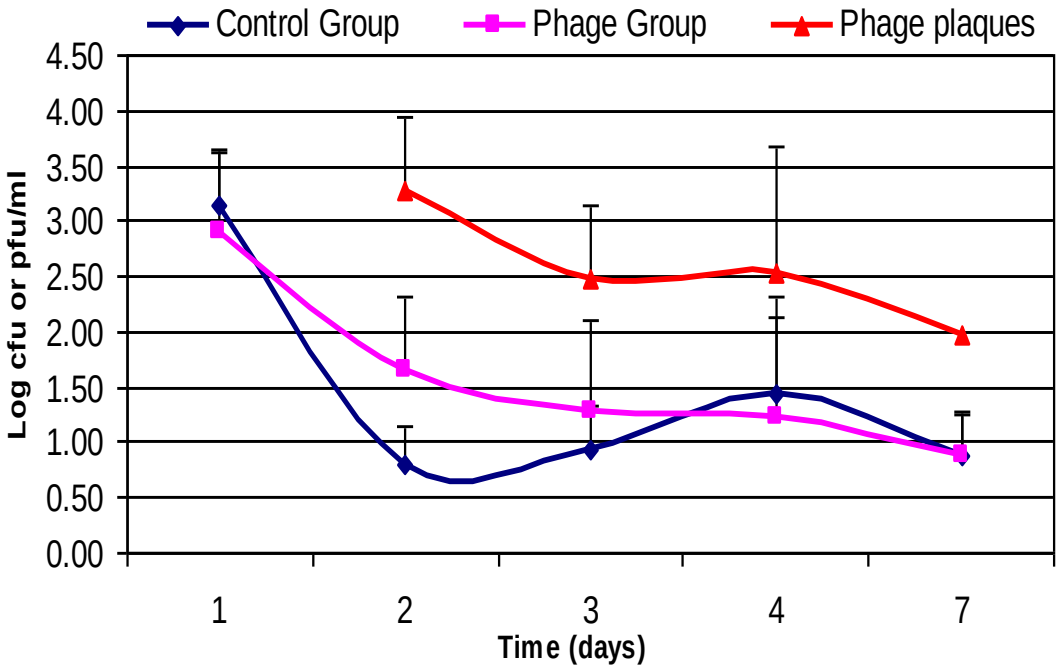
1. Pre-Harvest Intervention – phage application to the animal/plants **before** animal is slaughtered, or plant is harvested.

2. Post-Harvest Intervention – phage application **after** harvesting – either directly to the food or to the processing environment or packaging.

Target 1: *Escherichia coli* O157:H7

Pre-Harvest Intervention 1
Phage Intake in Cattle Drinking Water

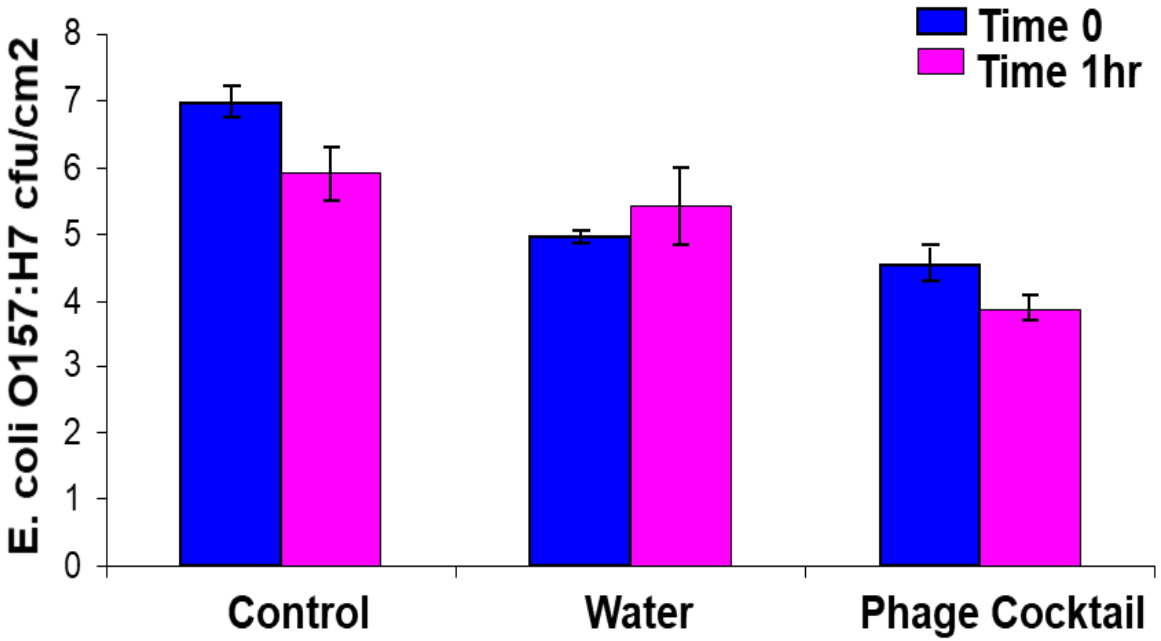
E. coli O157:H7
phage cocktail



Rapid shedding of the pathogen before phage application. Significantly, phages were found to transit the gut.

Pre-Harvest Intervention 2
Phage Application on Cattle Hide

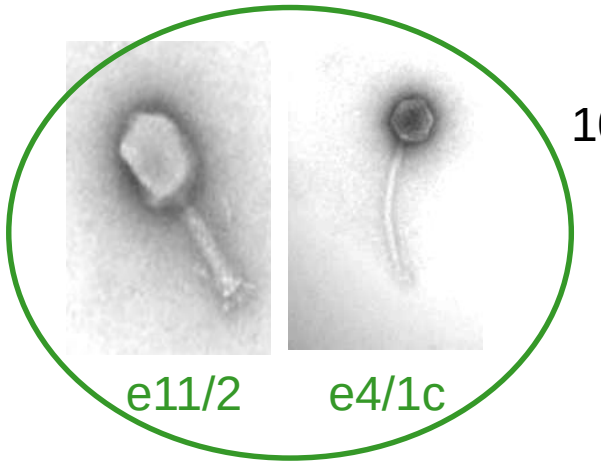
E. coli O157:H7
phage cocktail



Phage cocktail reduces *E.coli* O157:H7 numbers present on cattle hide.

Target 1: *Escherichia coli* O157:H7

Post-Harvest Intervention
Phage Application on Meat Surface

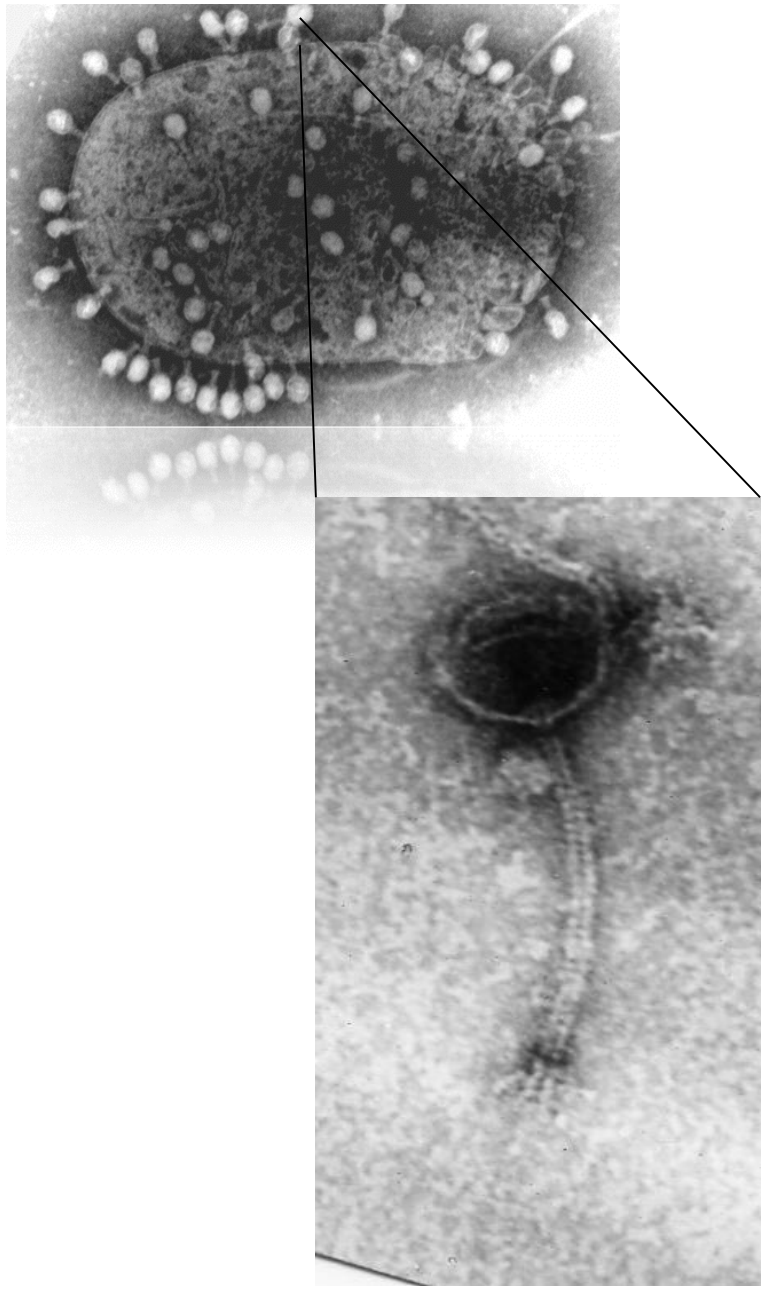


E. coli O157:H7-specific phage cocktail

10^3 cfu/g *E. coli*
10^6 pfu/ml phage cocktail

No *E. coli* detected on 7/9 pieces of steak meat treated with the phage cocktail

Phage as Control Agents in Food - Two Approaches



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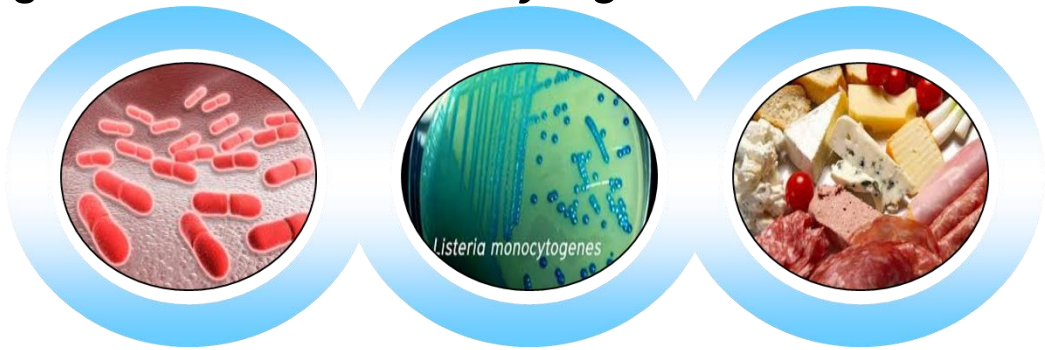
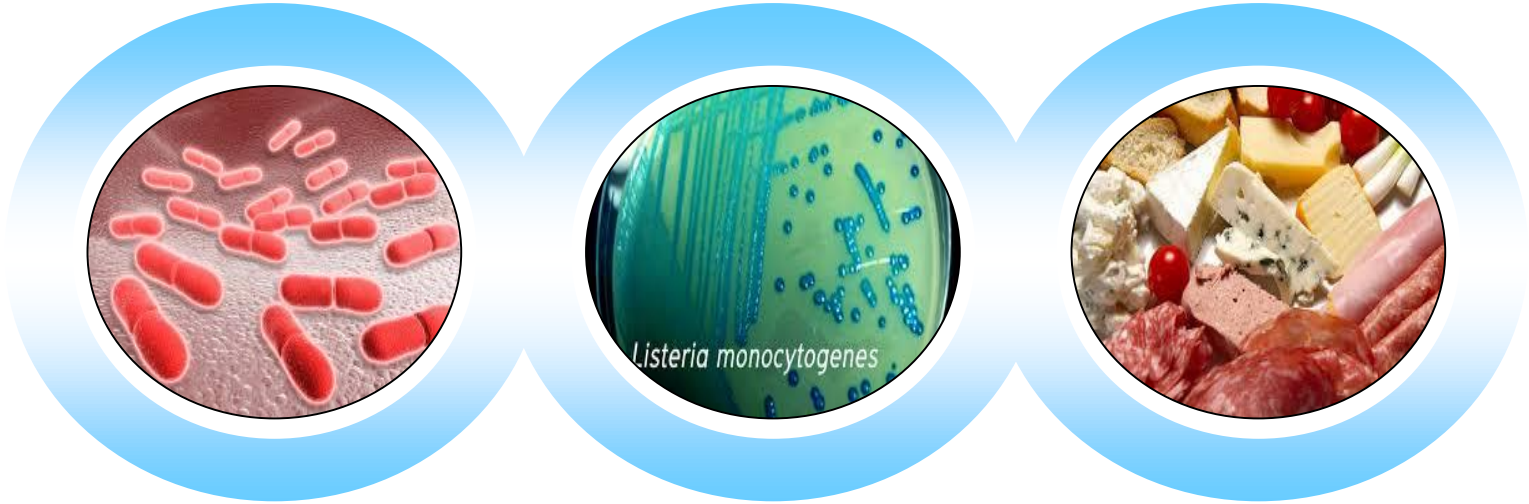


Target 2: *Listeria monocytogenes*

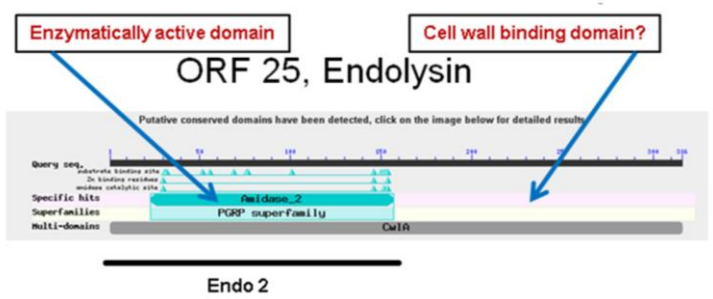
- Foodborne pathogen that causes listeriosis
- Relatively rare infection but has >20% fatality rate
- Associated primarily with ready-to-eat foods (no cooking step)
- 2018-2019: >200 fatalities in largest global outbreak in South Africa (polony)



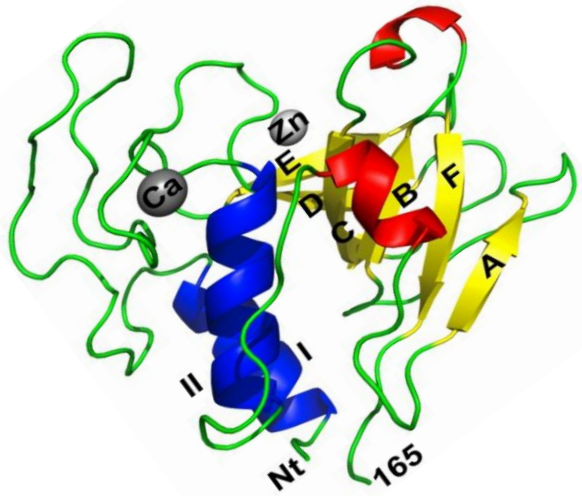
Phage Endolysin for Control of *Listeria monocytogenes*

L. monocytogenes phage 293

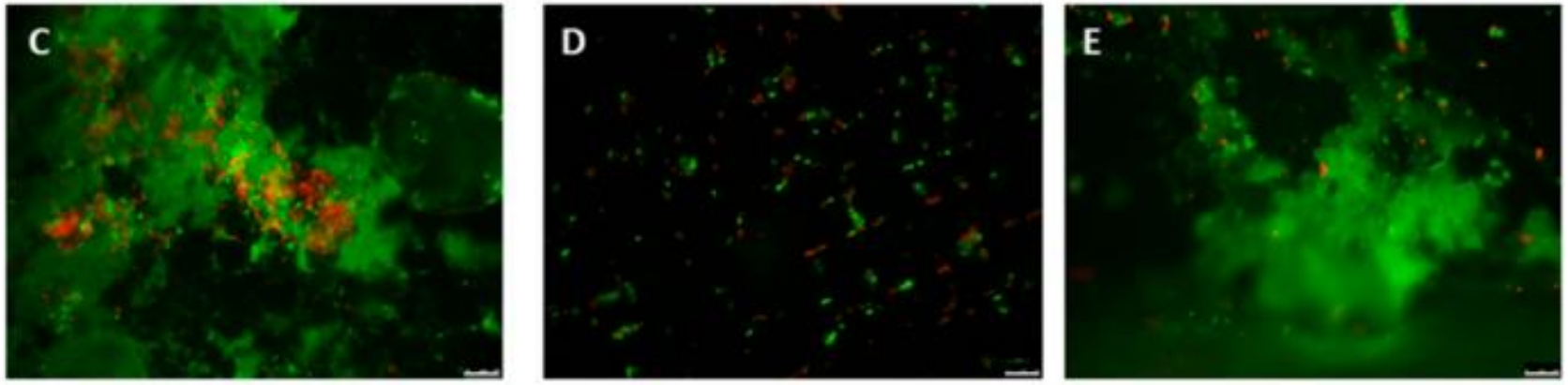
Genome Analysis



Enzyme Production



Inhibition of biofilm formation



Agriculture and Food Development Authority

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Currently Available Phage-Based Products

intralytix
SAFETY BY NATURE

PhageGuard
THE POWER OF NATURE

Elanco

OMNILYTICS™
THE PHAGE COMPANY

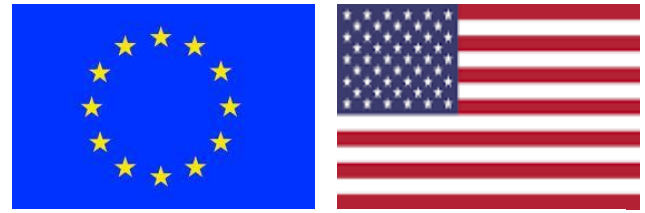
AgriPhage™

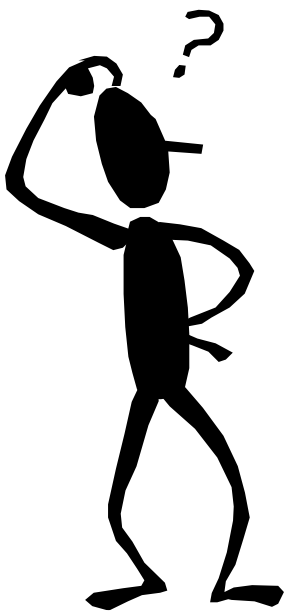
aps Biocontrol

EPIBIOME

Current Position on the Use of Phages in Agri-Food

- No common position on use of bacteriophages in agri-food systems.
- EU: considered by most member states (including IRL) as food additives (must be labelled).
- US: approved for use as processing aids (no labelling required).
- Progress in this area likely to be dictated by public health needs and tackling antimicrobial resistance in the microbial population.





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