

# [Gram-positive phage-host interactions](https://assignbuster.com/gram-positive-phage-host-interactions/)

[Health & Medicine](https://assignbuster.com/essay-subjects/health-n-medicine/)

Bacteriophage research has seen many peaks and troughs over the past century ascending with phage therapy and application in the early 1900's; a research peak which was largely overshadowed by the dawning of the antibiotic era, and which has now deservedly regained attention as an approach against the problematic rise in antibiotic-resistant pathogenic bacteria. Following this initial scientific highlight, the advent of molecular biology and biotechnology sparked a renewed interest in phages and their encoded enzymes and promoters, which are still employed as research tools today. Much of this research was conducted using phages of Gram-negative bacteria, particularly *Escherichia coli* , due to the reliability of the host and the ease of protein (over) production, in particular many enzymes, in a compatible host background. Consequently, coliphages such as T4 and lambda served as model phages in the development of molecular tools and the fundamental understanding of phage-host interactions. The advent of new generation sequencing technologies has in recent years provided a vast array of sequence data relating to Gram-positive phages and their hosts, which in turn has permitted the development of analogies between Gram-negative and Gram-positive phages. For example, sequence analysis of *Bacillus subtilis* and *Lactococcus lactis* phages SPP1 and Tuc2009, respectively, revealed genomes with a conserved gene and/or functional order relative to lambda, the main model for *Siphoviridae* phages. While the Gram-negative models have been extremely useful platforms, many questions have remained unanswered owing to the fundamental structural and compositional differences between the cell walls of Gram-negative and positive cells. In response to this knowledge gap, there has been a significant upsurge in research in the area of phages infecting Gram-positive bacteria and in particular, lactococcal phage-host interactions, which have now become one of the leading model systems along with the above-mentioned *Bacillus subtilis* phage SPP1 and the mycobacteriophage L5.

In the ensuing 11 articles, many key advances that now define our understanding of phage-host interactions of Gram-positive bacteria and their infecting phages are described. We collate these advances and define the current knowledge of cell wall structures that present the target molecule of phage attachment ( [Munsch-Alatossava and Alatossava, 2013](#B10) ; [Chapot-Chartier, 2014](#B3) ) and the phage-encoded adhesion complexes that phage employ to attach to their host in lactococci ( [Spinelli et al., 2014](#B11) ). Additionally, we explore the role of genomics in advancing knowledge on phages infecting previously underrepresented bacterial species that are of practical relevance to the food industry including the *Leuconostoc, Oenococcus* and *Weissella* ( [Kot et al., 2014](#B7) ; [Mahony and van Sinderen, 2014](#B9) ), and phage therapy including *Listeria* and *Clostridium* spp. ( [Hagens and Loessner, 2014](#B5) ; [Hargreaves and Clokie, 2014](#B6) ; [Ly-Chatain, 2014](#B8) ). Furthermore, the research articles reinforce the continuing need for isolation and characterisation of phage isolates to retain a current perspective on the ever-changing phage genomics landscape ( [Cavanagh et al., 2014](#B2) ) and the possibility of deriving and understanding anti-phage measures that may be harnessed in various biotechnology sectors, in particular the dairy industry ( [Ali et al., 2014](#B1) ; [Chirico et al., 2014](#B4) ).

## Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Acknowledgments

Jennifer Mahony is in receipt of a Technology Innovation Development Award (TIDA) (Ref. No. 14/TIDA/2287) funded by Science Foundation Ireland (SFI). Douwe van Sinderen is supported by a Principal Investigator award (Ref. No. 13/IA/1953) through SFI.

## References

Ali, Y., Koberg, S., Hessner, S., Sun, X., Rabe, B., Back, A., et al. (2014). Temperate *Streptococcus thermophilus* phages expressing superinfection exclusion proteins of the Ltp type. *Front. Microbiol* . 5: 98. doi: 10. 3389/fmicb. 2014. 00098

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24659988) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24659988) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00098) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=Y.+Ali&author=S.+Koberg&author=S.+Hessner&author=X.+Sun&author=B.+Rabe&author=A.+Back+&publication_year=2014&title=Temperate+Streptococcus+thermophilus+phages+expressing+superinfection+exclusion+proteins+of+the+Ltp+type&journal=Front.+Microbiol&volume=5&issue=98)

Cavanagh, D., Guinane, C. M., Neve, H., Coffey, A., Ross, R. P., Fitzgerald, G. F., et al. (2014). Phages of non-dairy lactococci: isolation and characterization of PhiL47, a phage infecting the grass isolate *Lactococcus lactis* ssp. *cremoris* DPC6860. *Front. Microbiol* . 4: 417. doi: 10. 3389/fmicb. 2013. 00417

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24454309) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24454309) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2013.00417)

Chapot-Chartier, M. P. (2014). Interactions of the cell-wall glycopolymers of lactic acid bacteria with their bacteriophages. *Front. Microbiol* . 5: 236. doi: 10. 3389/fmicb. 2014. 00236

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24904550) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24904550) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00236) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=M.+P.+Chapot-Chartier+&publication_year=2014&title=Interactions+of+the+cell-wall+glycopolymers+of+lactic+acid+bacteria+with+their+bacteriophages&journal=Front.+Microbiol&volume=5&issue=236)

Chirico, D., Gorla, A., Verga, V., Pedersen, P. D., Polgatti, E., Cava, A., et al. (2014). Bacteriophage-insensitive mutants for high quality Crescenza manufacture. *Front. Microbiol* . 5: 201. doi: 10. 3389/fmicb. 2014. 00201

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24834065) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24834065) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00201) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=D.+Chirico&author=A.+Gorla&author=V.+Verga&author=P.+D.+Pedersen&author=E.+Polgatti&author=A.+Cava+&publication_year=2014&title=Bacteriophage-insensitive+mutants+for+high+quality+Crescenza+manufacture&journal=Front.+Microbiol&volume=5&issue=201)

Hagens, S., and Loessner, M. J. (2014). Phages of *Listeria* offer novel tools for diagnostics and biocontrol. *Front. Microbiol* . 5: 159. doi: 10. 3389/fmicb. 2014. 00159

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24782847) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24782847) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00159) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=S.+Hagens&author=M.+J.+Loessner+&publication_year=2014&title=Phages+of+Listeria+offer+novel+tools+for+diagnostics+and+biocontrol&journal=Front.+Microbiol&volume=5&issue=159)

Hargreaves, K. R., and Clokie, M. R. (2014). *Clostridium difficile* phages: still difficult? *Front. Microbiol* . 5: 184. doi: 10. 3389/fmicb. 2014. 00184

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24808893) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24808893) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00184) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=K.+R.+Hargreaves&author=M.+R.+Clokie+&publication_year=2014&title=Clostridium+difficile+phages%3A+still+difficult%3F&journal=Front.+Microbiol&volume=5&issue=184)

Kot, W., Neve, H., Heller, K. J., and Vogensen, F. K. (2014). Bacteriophages of *Leuconostoc, Oenococcus* , and *Weissella* . *Front. Microbiol* . 5: 186. doi: 10. 3389/fmicb. 2014. 00186

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24817864) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24817864) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00186) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=W.+Kot&author=H.+Neve&author=K.+J.+Heller&author=F.+K.+Vogensen+&publication_year=2014&title=Bacteriophages+of+Leuconostoc,+Oenococcus,+and+Weissella&journal=Front.+Microbiol&volume=5&issue=186)

Ly-Chatain, M. H. (2014). The factors affecting effectiveness of treatment in phages therapy. *Front. Microbiol* . 5: 51. doi: 10. 3389/fmicb. 2014. 00051

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24600439) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24600439) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00051) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=M.+H.+Ly-Chatain+&publication_year=2014&title=The+factors+affecting+effectiveness+of+treatment+in+phages+therapy&journal=Front.+Microbiol&volume=5&issue=51)

Mahony, J., and van Sinderen, D. (2014). Current taxonomy of phages infecting lactic acid bacteria. *Front. Microbiol* . 5: 7. doi: 10. 3389/fmicb. 2014. 00007

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24478767) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24478767) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00007) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=J.+Mahony&author=D.+van+Sinderen+&publication_year=2014&title=Current+taxonomy+of+phages+infecting+lactic+acid+bacteria&journal=Front.+Microbiol&volume=5&issue=7)

Munsch-Alatossava, P., and Alatossava, T. (2013). The extracellular phage-host interactions involved in the bacteriophage LL-H infection of *Lactobacillus delbrueckii* ssp. *lactis* ATCC 15808. *Front. Microbiol* . 4: 408. doi: 10. 3389/fmicb. 2013. 00408

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24400001) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24400001) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2013.00408) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=P.+Munsch-Alatossava&author=T.+Alatossava+&publication_year=2013&title=The+extracellular+phage-host+interactions+involved+in+the+bacteriophage+LL-H+infection+of+Lactobacillus+delbrueckii+ssp.+lactis+ATCC+15808&journal=Front.+Microbiol&volume=4&issue=408)

Spinelli, S., Veesler, D., Bebeacua, C., and Cambillau, C. (2014). Structures and host-adhesion mechanisms of lactococcal siphophages. *Front. Microbiol* . 5: 3. doi: 10. 3389/fmicb. 2014. 00003

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=24474948) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=24474948) | [CrossRef Full Text](http://dx.doi.org/10.3389/fmicb.2014.00003) | [Google Scholar](http://scholar.google.com/scholar_lookup?author=S.+Spinelli&author=D.+Veesler&author=C.+Bebeacua&author=C.+Cambillau+&publication_year=2014&title=Structures+and+host-adhesion+mechanisms+of+lactococcal+siphophages&journal=Front.+Microbiol&volume=5&issue=3)