

## Description of Additional Supplementary Files

**Supplementary Dataset 1:** Top-five ranked phage candidates as predicted by PhageHostLearn for each of the 28 *Klebsiella* clinical isolates.

**Supplementary Dataset 2:** Laboratory confirmations of all of the 476 tested phage-host interactions with spot tests. Numbered cells reflect a confirmed interaction: -3 means the interaction was confirmed both at  $10^{-1}$  and  $10^{-3}$  dilutions; -1 means the interaction was only confirmed at a  $10^{-1}$  dilution, always in duplicate or triplicate. Blank cells reflect interactions that could not be confirmed.

**Supplementary Dataset 3:** Performance metrics of the *in vitro* validation, including the top-five hit ratio, the percentage of correct predictions, the true positives, the false positives and the false negatives.

**Supplementary Dataset 4:** Detailed look at the true positives, false positives and false negatives in the top-five predictions of the *in vitro* validation.

**Supplementary Dataset 5:** Identified antiphage defense systems in the 28 clinical isolates of the *in vitro* validation using DefenseFinder.