PROBLEM

Water contaminants, including E. coli and cyanobacteria, are affecting our health and ecosystems negatively.

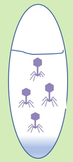
HYPOTHESIS

If Utah bodies of water are infected with harmful bacteria, then the same bodies of water will contain phages that can combat those bacteria species.

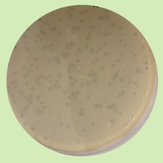
EXPERIMENTAL PROCEDURE

STEP 1: We traveled to various areas collecting water samples (Utah Lake, Strawberry Reservoir, Los Angles CA, etc.)

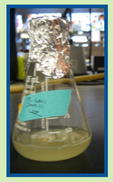
STEP 2: We mixed the water samples with a strain of E. coli to see if there is a phage hiding in them. Let it sit for 2 days.



STEP 3: We centrifuged to send all of the stuff that isn't necessary to the bottom of the tube, leaving the phage at the top.

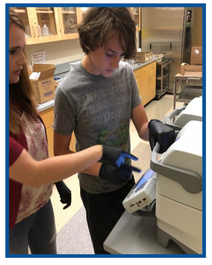


STEP 4: We mixed the phages with E. coli and plated in agar. Phages will appear as white spots because they have eaten the E. coli out of that area of the plate.



STEP 5: We picked the phage from the plate and put it with more *E. coli* to multiply the phage.

STEP 6: Once we had enough phage collected, we viewed them through electron microscope because they are too small for a normal light microscope.



ACKNOWLEDGEMENTS

Special thanks to the BYU Life Sciences Lab and Dr. Julianne Grose, Professor of Microbiology; Mr. Daniel Thompson, trained electron microscope expert; Mr. Ken Burgener and North Davis Sewage District; Mrs. Lora Gibbons and Ms. Amy Pace, teacher advisors; and a huge thank you to our families!

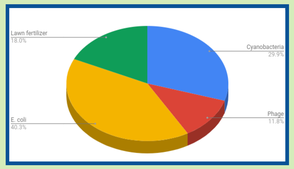
For a complete list of references used, see our Mission Folder.

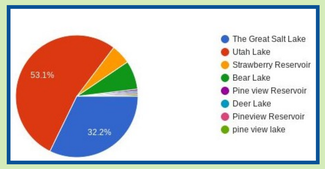
EDUCATIONAL OUTREACH

Educational outreach is important to our team, and part of what we wanted to accomplish with this project. We surveyed our fellow students to find out what they knew, and how they felt concerning Utah's water issues. These graphs show the survey results when we asked our school's 8th and 9th grade science classes what they thought was the most dangerous substance in our Utah bodies of water. We also asked what local body of water the students thought was the most harmful to human health. We used this information to guide us in what we needed to educate students about.

To help share our research, we developed a website. This is a place for educational information and also a forum where new ideas could be shared. There are things we can do to make a difference and help our water systems.

https://phantasticphagephinders.weebly.com/

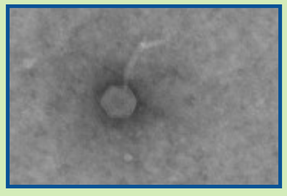




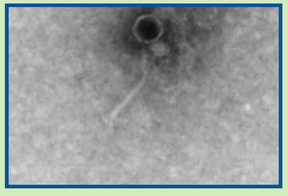
PHANTASTIC PHAGE PHINDERS

Rachel Amedee, Abigail Atkinson, Gavin Grose, Kate Watson

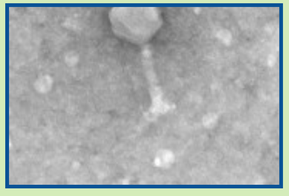
MEET OUR PHAGES



Gradenineblaze



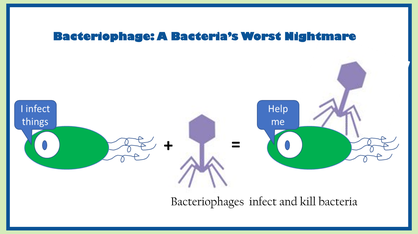
Romainenumeral

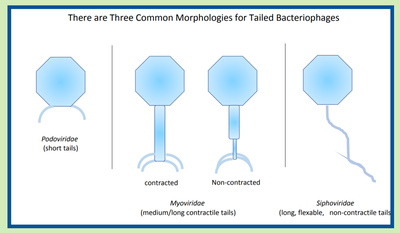


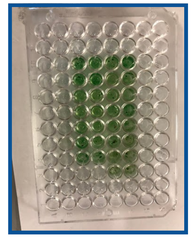
Ecyberbeast

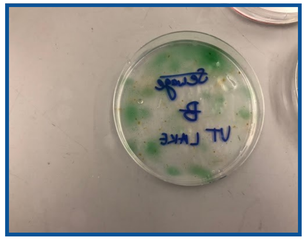
WHAT IS A PHAGE? CAN I NAME IT?

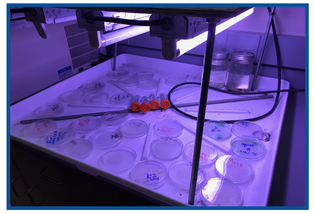
A phage (short for bacteriophage) is a type of virus that infects bacteria by replicating its DNA inside of the bacteria, with the process usually killing the bacteria. Phage can be used for many beneficial purposes, including to kill specific types of archaea and bacteria. Since our team discovered three brand new phages, we were able to name them. Our names for our phages had to concur with the widely-accepted phage naming rules. These rules include: must be 4 characters or longer, must start with a capital letter, must not exceed 14 characters. The names our team decided on are: Romainenumeral, Gradenineblaze, and Ecyberbeast.

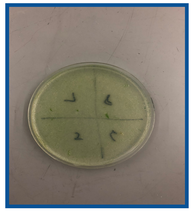












THINGS WE LEARNED THE HARD WAY

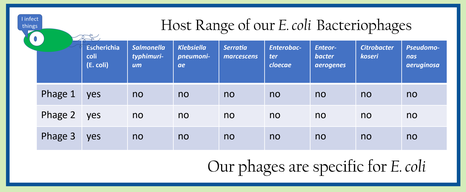
We started this experiment wanting to focus on cyanobacteria, but we discovered that cyanobacteria requires specific conditions and grows slowly. However, this failure inspired us to expand our goal to working with E. coli in an attempt to find a phage that could combat that bacteria type.

WHAT WE DISCOVERED ABOUT PHAGE

Our phages had two morphologies, which is great news. This can be compared to having two different antibiotics to treat the same illness, and provides two options if one of the morphologies fails in infecting that bacteria. We also discovered that our phage are narrow range, meaning they are specific to E.coli and cannot infect other types of bacteria. This is useful because we don't have to worry about our phages infecting other types of possibly beneficial bacteria.

NARROW RANGE PHAGE

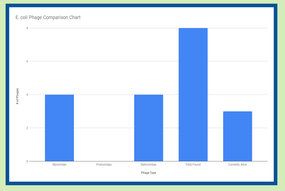
In order to verify that our phages would not harm other types of bacteria that could be beneficial, we tested our phages against several bacteria types similar to E. coli. The bacteria we tested were Salmonella typhimurium, Klebsiella pneumoniae, Serratia marcescens, Enterobacter cloacae, Enterobacter aerogenes, Citrobacter koseri, and Pseudomonas aeruginosa. These bacteria are the closest relatives to E. coli. With the tests, we saw that our phages did not harm or affect in any way the bacteria species which were not E. coli. So, we are pleased to discover that our phages were effective only against E. coli and, according to our tests, would not be harmful to other bacteria species. This makes our phages safe to use for humans and the environment.



Host Range of our *E. coli* Bacteriophages

	Escherichia coli (E. coli)	*Salmonella typhimurium*	*Klebsiella pneumoniae*	*Serratia marcescens*	*Enterobacter cloacae*	*Enterobacter aerogenes*	*Citrobacter koseri*	*Pseudomonas aeruginosa*
Phage 1	yes	no	no	no	no	no	no	no
Phage 2	yes	no	no	no	no	no	no	no
Phage 3	yes	no	no	no	no	no	no	no

Our phages are specific for *E. coli*



WHERE DO WE GO NEXT?

Throughout our project, we learned and gained much information about bacteria, phage, and the relationship they have. With our newly discovered phages, we can develop a possible substance that can fight harmful E. coli outbreaks in our agriculture and water. Our phage can be used to stabilize environments where E. coli have previously been problematic. We hope to continue to make an impact through continued research, education, and outreach.