Akhil Garg
April 27, 2015

Characterization of a 15-nucleotide repeat in subcluster A3 mycobacteriophages

Contents

[Introduction 1](#_Toc417901673)

[Methods and results 2](#_Toc417901674)

[Finding the most common repeats 2](#_Toc417901675)

[Extending the repeats 3](#_Toc417901676)

[Probability of the repeats 3](#_Toc417901677)

[Direction of the repeats 4](#_Toc417901678)

[Gene context of the repeats 5](#_Toc417901679)

[Location of the repeats within genomes 5](#_Toc417901680)

[Matches of the repeat outside of subcluster A3 6](#_Toc417901681)

[Conclusions 7](#_Toc417901682)

[References 8](#_Toc417901683)

[Appendix 8](#_Toc417901684)

[Gene contexts 8](#_Toc417901685)

[Genome location percentages 10](#_Toc417901686)

# Introduction

Genomes are responsible for encoding life. They do so by encoding proteins which regulate life processes such as metabolism, movement, and organization. Genomes have coding and non-coding (intergenic) regions. We know rather well what the coding regions do – code for proteins. But what about non-coding regions?

Some intergenic sequences are regulatory sequences near genes. For example, a transcription factor may bind near a gene to promote or repress transcription. However, there are still large sections of genomes whose function is not known. The study of these parts of the genome can lead to very interesting results. An example from the past decade is the discovery of clustered regularly interspaced short palindromic sequences (CRISPRs) in bacterial genomes. These sequences in the intergenic regions of prokaryotic genomes function as an immune system against attacking viruses, or bacteriophages (phages) ([Barrangou et al. 2007](http://www.sciencemag.org/content/315/5819/1709.full)). Nowadays, CRISPRs can be used as a laboratory method to effectively engineer genomes ([Cong et al. 2013](http://www.sciencemag.org/content/339/6121/819.full)). Generally, genome research can yield insights into gene regulation, and interactions between organisms.

Phages are at the edge of life – it is debatable even whether or not they are “living”. However, phages do have genomes. The genomes of phages are less well studied than the genomes of eukaryotes and bacteria. A better understanding of phage genomes could lead to new insights on how phages regulate themselves, and how they interact with their bacterial hosts.

Mycobacteriophages are phages that infect bacteria of the genus *Mycobacterium*. These phages are clustered into groups based on genome nucleotide similarity ([Hatfull et al. 2008](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2632949/)). [Cresawn et al. (2015)](http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118725#sec011) found a 17-nucleotide palindromic repeat in a group of closely-related mycobacteriophages called cluster O. This repeated sequence occurs throughout the genome, usually in intergenic regions. To study this phenomenon and to determine its importance, I asked why this repeat occurs in only cluster O phages. I tried to find the repeat in other mycobacteriophages. I found a different repeat in subcluster A3 mycobacteriophages. Subcluster A3 is a subset of cluster A mycobacteriophages.

An important step in understanding this repeat is characterizing the repeat. The repeat pattern is "[TC]GT[GT][GC][GT][AC]TGTCAAGT” (where [TC] means T or C). I determined that the subcluster A3 repeat occurs approximately 11 times per genome, the repeat is usually in the direction of transcription, and that the repeats are concentrated in the second half of the genome. These observations could help to determine the function of these sequences.

# Methods and results

BioBIKE, a visual programming interface, was used to analyze the mycobacteriophages genomes ([Elhai et al. 2009](http://nar.oxfordjournals.org/content/37/suppl_2/W28.full)). For this project, I used the ViroBIKE instance of BioBIKE.

## Finding the most common repeats

In order to find the cluster O repeat in other phages I searched for the most common 15-nucleotide sequences (15-mers) in all 336 mycobacteriophages in ViroBIKE. To do this, I used the function COUNTS-OF-K-MERS. This function loops through every 15-mer in the genome, and extracts the sequence. If the genome were of length 100, for example, this would lead to 86 sequences extracted.

Following the extraction, the function sorts the list of sequences. The function then counts the number of duplicates for each sequence in the list. Then, the counts are sorted from highest to lowest. The net effect is finding the most commonly repeated 15-mers in the genome.

Generally, a 15-mer search will find any repeat that is 15 nucleotides long or higher. I chose the number 15 because it would find the repeat that [Cresawn et al. (2015)](http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118725#sec011) found, in addition to any slightly shorter repeats.

This function applied to the mycobacteriophages Rockstar yields the output (only the first three sequences of the output are shown):

mycobacterium\_phage\_rockstar ((9 TGTGCGATGTCAAGT) (6 CTGTGCGATGTCAAG) (3 GTGCGATGTCAAGTC))

Throughout this analysis, I noted the cluster of phages which had a repeat with copy number greater than 7. ([PhagesDB](http://phagesdb.org/) is a database of mycobacteriophages clusters.) I looked through the sequence and focused on repeats that were dispersed – that is – repeats that weren’t connected in tandem. I found the cluster O repeat in this manner [Cresawn et al. (2015)](http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118725#sec011), and I noticed that subcluster A3 mycobacteriophages seemed to contain a repeated sequence similar to TGTGCGATGTCAAGT. From the most common 15-mers, the pattern of the repeat is "[TC]GT[GT][GC][GT][AC]TGTCAAGT" (where [TC] indicates T or C).

I then searched for this pattern in all subcluster A3 mycobacteriophages in the ViroBIKE database. The 16 phages in the database are: Bxz2, Jhc117, Microwolf, Rockstar, Vix, Jobu08, Phantastic, Anubis, Heldan, Methuselah, Marquardt, Phoxy, Spike509, Farber, QuinnKiro, and Tiffany.

## Extending the repeats

It is possible that the repeats are longer than 15 nucleotides. In order to determine if I could extend the repeat, I examined the 3 nucleotides before and after the repeats. I extracted these sequences into a new list. Following the extraction, I calculated the *information content* of each position. The information content describes how random each nucleotide position is. A position that has an equal probability of being A, C, G, or T has an information content of 0 bits, and a position that is always G has an information content of 2 bits. For the subcluster A3 sequences, this is a graph of the information content of the neighborhood of the repeats:



The x-axis represents the nucleotide position, and the y-axis represents the information content of the sequence. Positions 4 – 17 represent the original repeat, and positions 1 – 3 and 18 – 20 represent 3 nucleotides flanking the repeats. The information content drops to the left and right of the middle 15 positions. Thus, the repeat is 15 nucleotides long, and not longer.

## Probability of the repeats

15-mers are highly unlikely to appear more than once in a genome. On average, there are 11 matches per genome. The probability of this is given by the Poisson expression:

Where equals the expected number of hits, or .

The mean length of a subcluster A3 genome is nucleotides. The average GC fraction of the genomes is 64%. Thus, the probability of the sequence "[TC]GT[GT][GC][GT][AC]TGTCAAGT" is . .

Substituting into the Poisson expression:

The probability is phenomenally low. There is no way that this repeat could have arisen by chance.

These numbers were confirmed by finding the pattern "[TC]GT[GT][GC][GT][AC]TGTCAAGT" in randomly-generated DNA with the nucleotide composition of the subcluster A3 mycobacteriophage Rockstar. In 10 attempts, there were zero matches in total, which suggests that this sequence did not arise by chance. Even in a random DNA sequence 1 million nucleotides long, zero matches were found.

## Direction of the repeats

In order to better characterize the repeat, I checked which direction the repeat occurred in. This could help determine which parts of the genome the repeat would be found in: forward transcribed or backwards transcribed.

I looked through each sequence to find the direction of the repeat. There is a marked bias for the repeat to occur in the forward direction:

|  |  |  |
| --- | --- | --- |
| **Phage** | **# forward**  | **# backward** |
| Bxz2 | 11 |  |
| Jhc117 | 11 |  |
| Microwolf | 12 |  |
| Rockstar | 10 | 2 |
| Vix | 11 |  |
| Heldan | 9 | 2 |
| Methuselah | 12 |  |
| Jobu08 | 12 |  |
| Phantastic | 9 | 1 |
| Anubis | 12 |  |
| Marquardt | 11 |  |
| Phoxy | 12 |  |
| Spike509\* | 12 |  |
| Farber | 11 |  |
| QuinnKiro | 8 | 2 |
| Tiffany | 11 |  |

\*The data file for Spike509 is not good, so the number can’t be trusted.

## Gene context of the repeats

Further insights into the repeats could be gained by examining whether or not the repeat occurred within genes, and which genes were located around the repeats. The genomic context of each repeat was analyzed using the BioBIKE function CONTEXT-OF. The results of this analysis is located in the [Appendix](#_Gene_contexts). CONTEXT-OF returns, for each repeat:

* Whether or not it is within a gene
* If not within a gene, whether it is between parallel genes (surrounding two genes are transcribed in the same direction), convergent genes (surrounding two genes are transcribed towards the repeat, or divergent genes (surrounding two genes are transcribed away from the repeat).
* The name of the nearest genes and the distance to them (if outside of a gene) or the distance to the start or end (if inside a gene).
* The direction of transcription of nearby genes.

In general, most of the repeats are at least partially intergenic in between backwards-transcribed genes. For genes that are transcribed in the forward direction, the repeat occurs backwards, and vice versa.

All of the repeats that are completely within genes are contained in genes that are annotated as “hypothetical” or “NIL”.

## Location of the repeats within genomes

I created an algorithm that takes the start coordinate of each repeat, and finds its location within the genome as a percentage of the genome. A repeat near the beginning of the genome will have a lower percentage than a repeat near the end of the genome. The raw percentages are located in the [Appendix](#_Genome_location_percentages). I plotted the percentages in a bar graph:



The repeats tend to be in the second half of the genome. A large spike in the 90%+ range is due to many of the repeats being located after all of the genes in an intergenic region.

## Matches of the repeat outside of subcluster A3

More information could be gained by searching for the repeat in the genomes of organisms outside of subcluster A3.

There were no matches of the pattern "[TC]GT[GT][GC][GT][AC]TGTCAAGT" in any mycobacteria. I also searched for pattern in all mycobacteriophages of the ViroBIKE database. It exists in some phages outside of subcluster A3:

|  |  |  |
| --- | --- | --- |
| **Phage name** | **Cluster** | **Copy number** |
| Backyardigan | A4 | 10 |
| Severus | A10 | 10 |
| Twister | A10 | 10 |
| Arturo | A4 | 9 |
| Dhanush | A4 | 9 |
| Goose | A10 | 9 |
| Icleared | A4 | 9 |
| Kampy | A4 | 9 |
| Lhtscc | A4 | 9 |
| Obama12 | A4 | 9 |
| Peaches | A4 | 9 |
| Rebeuca | A10 | 9 |
| Tirotheta9 | A4 | 9 |
| Bellusterra | A4 | 8 |
| Flux | A4 | 8 |
| Medusa | A4 | 8 |
| Meezee | A4 | 8 |
| Melvin | A4 | 8 |
| Nyxis | A4 | 8 |
| Sabertooth | A4 | 8 |
| Shaka | A4 | 8 |
| Wile | A4 | 8 |
| Rhyno | A10 | 7 |
| Jovo | A5 | 2 |
| Timshel | A7 | 2 |
| Airmid | A5 | 1 |
| Benedict | A5 | 1 |
| Conspiracy | A5 | 1 |
| Cuco | A5 | 1 |
| Eltiger69 | A5 | 1 |
| George | A5 | 1 |
| Littlecherry | A5 | 1 |
| Tiger | A5 | 1 |
| **Average:** | 6.4 |

This repeat is prevalent in subcluster A4 and A10 mycobacteriophages, and in a small number in subcluster A5 mycobacteriophages.

# Conclusions

A novel 15-nucleotide repeated sequence exists in the sequences of subcluster A3 mycobacteriophages. This repeat could not have arisen by chance. It seems that this repeat also exists in subcluster A4 and A10 mycobacteriophages, and in a lower copy number in subcluster A5 phages. This trend may provide some evidence of how closely related these clusters are. The repeat copy number suggests that subclusters A3, A4, and A10 are more closely related than subcluster A5.

The repeat always exists in the opposite direction to the direction of transcription, in between parallel genes. This strongly suggests that the repeat is implicated in transcription of genes, and not as a lifestyle switch like the cro/cI switch in the lambda phage ([Herskowitz I, Hagen D 1980](http://www.annualreviews.org/doi/abs/10.1146/annurev.ge.14.120180.002151)). Since there are around 11 repeats per genome, it is possible that this repeat governs the transcription of a small number—less than 11—of genes.

All of the repeats that are completely located within genes are within genes that are annotated as “hypothetical protein” or “NIL”. The existence of these genes is questionable. These genes may be longer or shorter than their annotation, or they may not exist at all. These repeats likely are a strictly intergenic phenomenon.

Since the repeats seem to be clustered in the second half of the genome, it appears that the repeat could be related to:

1. The genes that tend to be encoded in the second half of the genome, or
2. If the genomes are circular, the way the start of the genome is determined.

Further analysis of the genes surrounding the repeats might lead to more understanding of these repeats. The fact that the repeats are located in the second half of genomes is an interesting phenomenon to study further.

# References

* Barrangou R, et al. (2007).

CRISPR Provides Acquired Resistance Against Viruses in Prokaryotes.

Science 315(5819): 1709-1712.

<http://www.sciencemag.org/content/315/5819/1709.full>

* Cong L et al. (2013).

Multiplex Genome Engineering Using CRISPR/Cas Systems.

Science 339(6121): 819-823

<http://www.sciencemag.org/content/339/6121/819.full>

* Cresawn SG et al. (2015).

Comparative Genomics of Cluster O Mycobacteriophages.

PLoS ONE 10(3): e0118725.

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118725>

* Elhai J et al. (2009).

BioBIKE: A Web-based, programmable, integrated biological knowledge base.

Nucl Acids Res. 37: W28-W32.

<http://nar.oxfordjournals.org/content/37/suppl_2/W28.full>

* Hatfull GF, Cresawn SG, Hendrix, RW. (2008).

Comparative genomics of the mycobacteriophages: Insights into bacteriophage evolution.

Res Microbiol 159(5): 332-339.

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2632949/>

* Herskowitz I, Hagen D. (1980).

The lysis-lysogeny decision of phage lambda: explicit programming and responsiveness.

Annu Rev Genet 1980(14): 399-445.

<http://www.annualreviews.org/doi/abs/10.1146/annurev.ge.14.120180.002151>

* PhagesDB mycobacteriophage database

<http://phagesdb.org/>

Subcluster A3: <http://phagesdb.org/subclusters/A3/>

# Appendix

## Gene contexts

Zoom in to see the function output. “Start coord output” represents the context of the start coordinate of each repeat. “End coord output” represents the context of the end coordinate of each repeat.

Explanation of the output is located [above](#_Gene_context_of), and more detailed documentation is available from the [function’s documentation](http://biobike-9003.csbc.vcu.edu/new-help/help-function-documentation-url?PKG=GARGA439955&NAME=CONTEXT%2fS-OF&PACKAGE=BBI). The letter in the first column of the output means:

* "I" if the coordinate lies within a gene
* "P" if the coordinate lies between parallel genes
* "C" if the coordinate lies between convergent genes
* "D" if the coordinate lies between divergent genes
* "U" if the coordinate lies upstream from a gene and between the gene and the end of its linear contig
* "N" if the coordinate lies downstream from a gene and between the gene and the end of its linear contig

Generally, “N” is underrepresented in the output – that is, some repeats that should be classified as “D” or “C” instead.

|  |  |  |  |
| --- | --- | --- | --- |
| **Phage** | **Start coord output** | **End coord output** | **Notes** |
| Bxz2 | P NC\_004682.Bxz2p41 NC\_004682.Bxz2p42 11 20 B P NC\_004682.Bxz2p46 NC\_004682.Bxz2p47 46 14 B P NC\_004682.Bxz2p51 NC\_004682.Bxz2p52 129 16 B P NC\_004682.Bxz2p56 NC\_004682.Bxz2p57 8 16 B P NC\_004682.Bxz2p61 NC\_004682.Bxz2p62 15 9 B P NC\_004682.Bxz2p65 NC\_004682.Bxz2p66 9 42 B P NC\_004682.Bxz2p69 NC\_004682.Bxz2p70 13 16 B P NC\_004682.Bxz2p82 NC\_004682.Bxz2p83 15 16 B P NC\_004682.Bxz2p83 NC\_004682.Bxz2p84 11 16 B D NC\_004682.Bxz2p86 NC\_004682.Bxz2p01 479 1260 B D NC\_004682.Bxz2p86 NC\_004682.Bxz2p01 537 1202 B  | P [NC\_004682.Bxz2p41](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p41) [NC\_004682.Bxz2p42](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p42) 25 6 B I [NC\_004682.Bxz2p47](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p47) NIL 0 581 B P [NC\_004682.Bxz2p51](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p51) [NC\_004682.Bxz2p52](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p52) 143 2 B P [NC\_004682.Bxz2p56](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p56) [NC\_004682.Bxz2p57](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p57) 22 2 B I [NC\_004682.Bxz2p62](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p62) NIL 5 804 B P [NC\_004682.Bxz2p65](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p65) [NC\_004682.Bxz2p66](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p66) 23 28 B P [NC\_004682.Bxz2p69](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p69) [NC\_004682.Bxz2p70](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p70) 27 2 B P [NC\_004682.Bxz2p82](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p82) [NC\_004682.Bxz2p83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p83) 29 2 B P [NC\_004682.Bxz2p83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p83) [NC\_004682.Bxz2p84](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p84) 25 2 B D [NC\_004682.Bxz2p86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p86) [NC\_004682.Bxz2p01](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p01) 493 1246 B D [NC\_004682.Bxz2p86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p86) [NC\_004682.Bxz2p01](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=NC_004682.Bxz2p01) 551 1188 B  | 9 repeats are in the forward direction in between genes that are transcribed backwards. Twice, the end overlaps the next gene. The other 2 lie in a long intergenic region at the end of the genome. |
| Jhc117 | P jhc117.jhc1170047 jhc117.jhc1170048 11 20 B P jhc117.jhc1170052 jhc117.jhc1170053 46 14 B I jhc117.jhc1170057 NIL 710 12 B P jhc117.jhc1170061 jhc117.jhc1170062 231 16 B P jhc117.jhc1170066 jhc117.jhc1170067 15 9 B I jhc117.jhc1170068 NIL 263 27 B P jhc117.jhc1170072 jhc117.jhc1170073 13 16 B P jhc117.jhc1170084 jhc117.jhc1170085 15 16 B P jhc117.jhc1170085 jhc117.jhc1170086 11 16 B U jhc117.jhc1170088 NIL 479 725 B U jhc117.jhc1170088 NIL 537 667 B  | P [jhc117.jhc1170047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170047) [jhc117.jhc1170048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170048) 25 6 B I [jhc117.jhc1170053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170053) NIL 0 590 B P [jhc117.jhc1170057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170057) [jhc117.jhc1170058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170058) 2 2 B P [jhc117.jhc1170061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170061) [jhc117.jhc1170062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170062) 245 2 B I [jhc117.jhc1170067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170067) NIL 5 804 B I [jhc117.jhc1170068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170068) NIL 277 13 B P [jhc117.jhc1170072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170072) [jhc117.jhc1170073](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170073) 27 2 B P [jhc117.jhc1170084](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170084) [jhc117.jhc1170085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170085) 29 2 B P [jhc117.jhc1170085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170085) [jhc117.jhc1170086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170086) 25 2 B U [jhc117.jhc1170088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170088) NIL 493 711 B U [jhc117.jhc1170088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jhc117.jhc1170088) NIL 551 653 B  | One of the repeats is completely within a gene, 117068. That gene is annotated "NIL". The rest are at least partially in intergenic regions. The genes around the repeats are transcribed backwards. |
| Microwolf | P microwolf.microwolf0047 microwolf.microwolf0048 11 20 B P microwolf.microwolf0052 microwolf.microwolf0053 46 14 B I microwolf.microwolf0057 NIL 710 12 B P microwolf.microwolf0061 microwolf.microwolf0062 231 16 B P microwolf.microwolf0066 microwolf.microwolf0067 15 9 B I microwolf.microwolf0068 NIL 263 45 B P microwolf.microwolf0072 microwolf.microwolf0073 13 16 B P microwolf.microwolf0085 microwolf.microwolf0086 15 16 B P microwolf.microwolf0086 microwolf.microwolf0087 11 16 B U microwolf.microwolf0088 NIL 511 716 B U microwolf.microwolf0088 NIL 569 658 B U microwolf.microwolf0088 NIL 788 439 B  | P [microwolf.microwolf0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0047) [microwolf.microwolf0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0048) 25 6 B I [microwolf.microwolf0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0053) NIL 0 605 B P [microwolf.microwolf0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0057) [microwolf.microwolf0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0058) 2 2 B P [microwolf.microwolf0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0061) [microwolf.microwolf0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0062) 245 2 B I [microwolf.microwolf0067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0067) NIL 5 804 B I [microwolf.microwolf0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0068) NIL 277 31 B P [microwolf.microwolf0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0072) [microwolf.microwolf0073](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0073) 27 2 B P [microwolf.microwolf0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0085) [microwolf.microwolf0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0086) 29 2 B P [microwolf.microwolf0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0086) [microwolf.microwolf0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0087) 25 2 B U [microwolf.microwolf0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0088) NIL 525 702 B U [microwolf.microwolf0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0088) NIL 583 644 B U [microwolf.microwolf0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=microwolf.microwolf0088) NIL 802 425 B  | The repeat within 0068 is completely within a gene, but the others are outside of genes. The genes around the repeats are transcribed backwards. |
| Rockstar | P rockstar.rockstar0022 rockstar.rockstar0023 20 36 F P rockstar.rockstar0015 rockstar.rockstar0016 20 53 F P rockstar.rockstar0056 rockstar.rockstar0057 4 27 B I rockstar.rockstar0061 NIL 547 274 B P rockstar.rockstar0063 rockstar.rockstar0064 18 43 B I rockstar.rockstar0066 NIL 323 45 B P rockstar.rockstar0069 rockstar.rockstar0070 11 16 B I rockstar.rockstar0070 NIL 487 310 B I rockstar.rockstar0076 NIL 425 12 B U rockstar.rockstar0079 NIL 89 1151 B U rockstar.rockstar0079 NIL 466 774 B U rockstar.rockstar0079 NIL 546 694 B  | P [rockstar.rockstar0022](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0022) [rockstar.rockstar0023](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0023) 4 52 F P [rockstar.rockstar0015](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0015) [rockstar.rockstar0016](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0016) 4 69 F P [rockstar.rockstar0056](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0056) [rockstar.rockstar0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0057) 18 13 B I [rockstar.rockstar0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0061) NIL 561 260 B P [rockstar.rockstar0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0063) [rockstar.rockstar0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0064) 32 29 B I [rockstar.rockstar0066](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0066) NIL 337 31 B P [rockstar.rockstar0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0069) [rockstar.rockstar0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0070) 25 2 B I [rockstar.rockstar0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0070) NIL 501 296 B P [rockstar.rockstar0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0076) [rockstar.rockstar0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0077) 2 2 B U [rockstar.rockstar0079](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0079) NIL 103 1137 B U [rockstar.rockstar0079](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0079) NIL 480 760 B U [rockstar.rockstar0079](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=rockstar.rockstar0079) NIL 560 680 B  | It seems that forward transcription corresponds to a reverse sequence, and vice versa. |
| Vix | P [vix.vix0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0047) [vix.vix0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0048) 11 20 B P [vix.vix0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0052) [vix.vix0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0053) 46 14 B I [vix.vix0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0057) NIL 710 12 B P [vix.vix0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0061) [vix.vix0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0062) 231 16 B P [vix.vix0066](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0066) [vix.vix0067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0067) 15 9 B I [vix.vix0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0068) NIL 263 45 B P [vix.vix0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0072) [vix.vix0073](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0073) 13 16 B P [vix.vix0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0085) [vix.vix0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0086) 15 16 B P [vix.vix0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0086) [vix.vix0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0087) 11 145 B U [vix.vix0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0088) NIL 479 726 B U [vix.vix0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0088) NIL 537 668 B  | P [vix.vix0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0047) [vix.vix0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0048) 25 6 B I [vix.vix0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0053) NIL 0 590 B P [vix.vix0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0057) [vix.vix0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0058) 2 2 B P [vix.vix0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0061) [vix.vix0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0062) 245 2 B I [vix.vix0067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0067) NIL 5 804 B I [vix.vix0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0068) NIL 277 31 B P [vix.vix0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0072) [vix.vix0073](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0073) 27 2 B P [vix.vix0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0085) [vix.vix0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0086) 29 2 B P [vix.vix0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0086) [vix.vix0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0087) 25 131 B U [vix.vix0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0088) NIL 493 712 B U [vix.vix0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=vix.vix0088) NIL 551 654 B  |  |
| Heldan | I heldan.heldan0024 NIL 12 898 F P heldan.heldan0015 heldan.heldan0016 20 58 F I heldan.heldan0057 NIL 62 30 B I heldan.heldan0062 NIL 550 280 B P heldan.heldan0064 heldan.heldan0065 18 43 B I heldan.heldan0067 NIL 320 45 B P heldan.heldan0070 heldan.heldan0071 20 16 B I heldan.heldan0071 NIL 487 307 B I heldan.heldan0090 NIL 24 440 F I heldan.heldan0090 NIL 394 70 F N heldan.heldan0090 NIL 10 693 F  | P [heldan.heldan0022](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0022) [heldan.heldan0023](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0023) 4 4 F P [heldan.heldan0015](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0015) [heldan.heldan0016](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0016) 4 74 F I [heldan.heldan0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0057) NIL 76 16 B I [heldan.heldan0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0062) NIL 564 266 B P [heldan.heldan0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0064) [heldan.heldan0065](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0065) 32 29 B I [heldan.heldan0067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0067) NIL 334 31 B P [heldan.heldan0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0070) [heldan.heldan0071](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0071) 34 2 B I [heldan.heldan0071](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0071) NIL 501 293 B I [heldan.heldan0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0090) NIL 38 426 F I [heldan.heldan0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0090) NIL 408 56 F N [heldan.heldan0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=heldan.heldan0090) NIL 24 679 F  | Six of these repeats are within genes, which is much different from everything else. |
| Methuselah | P [methuselah.methuselahH\_44](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_44) [methuselah.methuselahH\_45](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_45) 11 20 B P [methuselah.methuselahH\_48](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_48) [methuselah.methuselahH\_49](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_49) 46 14 B I [methuselah.methuselahH\_53](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_53) NIL 710 12 B P [methuselah.methuselahH\_58](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_58) [methuselah.methuselahH\_59](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_59) 8 16 B P [methuselah.methuselahH\_63](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_63) [methuselah.methuselahH\_64](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_64) 15 9 B I [methuselah.methuselahH\_65](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_65) NIL 263 45 B P [methuselah.methuselahH\_69](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_69) [methuselah.methuselahH\_70](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_70) 13 16 B P [methuselah.methuselahH\_82](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_82) [methuselah.methuselahH\_83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_83) 15 16 B P [methuselah.methuselahH\_83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_83) [methuselah.methuselahH\_84](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_84) 11 16 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 479 713 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 537 655 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 766 426 B  | P [methuselah.methuselahH\_44](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_44) [methuselah.methuselahH\_45](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_45) 25 6 B I [methuselah.methuselahH\_49](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_49) NIL 0 587 B P [methuselah.methuselahH\_53](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_53) [methuselah.methuselahH\_54](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_54) 2 2 B P [methuselah.methuselahH\_58](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_58) [methuselah.methuselahH\_59](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_59) 22 2 B I [methuselah.methuselahH\_64](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_64) NIL 5 804 B I [methuselah.methuselahH\_65](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_65) NIL 277 31 B P [methuselah.methuselahH\_69](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_69) [methuselah.methuselahH\_70](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_70) 27 2 B P [methuselah.methuselahH\_82](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_82) [methuselah.methuselahH\_83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_83) 29 2 B P [methuselah.methuselahH\_83](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_83) [methuselah.methuselahH\_84](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_84) 25 2 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 493 699 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 551 641 B U [methuselah.methuselahH\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=methuselah.methuselahH_86) NIL 780 412 B  |  |
| Jobu08 | P [jobu08.jobu088\_46](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_46) [jobu08.jobu088\_47](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_47) 11 20 B P [jobu08.jobu088\_51](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_51) [jobu08.jobu088\_52](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_52) 46 14 B I [jobu08.jobu088\_56](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_56) NIL 710 12 B P [jobu08.jobu088\_61](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_61) [jobu08.jobu088\_62](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_62) 8 16 B P [jobu08.jobu088\_66](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_66) [jobu08.jobu088\_67](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_67) 15 9 B I [jobu08.jobu088\_68](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_68) NIL 263 45 B P [jobu08.jobu088\_72](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_72) [jobu08.jobu088\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_73) 12 16 B P [jobu08.jobu088\_85](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_85) [jobu08.jobu088\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_86) 15 16 B P [jobu08.jobu088\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_86) [jobu08.jobu088\_87](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_87) 11 16 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 513 718 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 571 660 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 790 441 B  | P [jobu08.jobu088\_46](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_46) [jobu08.jobu088\_47](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_47) 25 6 B I [jobu08.jobu088\_52](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_52) NIL 0 590 B P [jobu08.jobu088\_56](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_56) [jobu08.jobu088\_57](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_57) 2 2 B P [jobu08.jobu088\_61](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_61) [jobu08.jobu088\_62](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_62) 22 2 B I [jobu08.jobu088\_67](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_67) NIL 5 804 B I [jobu08.jobu088\_68](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_68) NIL 277 31 B P [jobu08.jobu088\_72](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_72) [jobu08.jobu088\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_73) 26 2 B P [jobu08.jobu088\_85](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_85) [jobu08.jobu088\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_86) 29 2 B P [jobu08.jobu088\_86](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_86) [jobu08.jobu088\_87](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_87) 25 2 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 527 704 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 585 646 B U [jobu08.jobu088\_88](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=jobu08.jobu088_88) NIL 804 427 B  |  |
| Phantastic | P [phantastic.phantasticC\_22](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_22) [phantastic.phantasticC\_23](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_23) 20 38 F I [phantastic.phantasticC\_58](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_58) NIL 65 30 B I [phantastic.phantasticC\_64](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_64) NIL 547 280 B P [phantastic.phantasticC\_66](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_66) [phantastic.phantasticC\_67](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_67) 18 43 B I [phantastic.phantasticC\_69](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_69) NIL 326 45 B P [phantastic.phantasticC\_72](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_72) [phantastic.phantasticC\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_73) 11 16 B I [phantastic.phantasticC\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_73) NIL 487 307 B I [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 89 213 B U [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 161 786 B U [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 241 706 B  | P [phantastic.phantasticC\_22](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_22) [phantastic.phantasticC\_23](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_23) 4 54 F I [phantastic.phantasticC\_58](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_58) NIL 79 16 B I [phantastic.phantasticC\_64](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_64) NIL 561 266 B P [phantastic.phantasticC\_66](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_66) [phantastic.phantasticC\_67](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_67) 32 29 B I [phantastic.phantasticC\_69](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_69) NIL 340 31 B P [phantastic.phantasticC\_72](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_72) [phantastic.phantasticC\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_73) 25 2 B I [phantastic.phantasticC\_73](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_73) NIL 501 293 B I [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 103 199 B U [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 175 772 B U [phantastic.phantasticC\_92](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phantastic.phantasticC_92) NIL 255 692 B  | It seems that forward transcription corresponds to a reverse sequence, and vice versa. |
| Anubis | P anubis.ANUBIS-0047 anubis.ANUBIS-0048 11 20 B P anubis.ANUBIS-0052 anubis.ANUBIS-0053 46 14 B I anubis.ANUBIS-0057 NIL 710 12 B P anubis.ANUBIS-0062 anubis.ANUBIS-0065 231 16 B I anubis.ANUBIS-0069 NIL 245 12 B I anubis.ANUBIS-0073 NIL 263 45 B P anubis.ANUBIS-0077 anubis.ANUBIS-0078 13 16 B I anubis.ANUBIS-0092 NIL 323 12 B P anubis.ANUBIS-0093 anubis.ANUBIS-0094 11 16 B D anubis.ANUBIS-0096 anubis.ANUBIS-0001 479 744 B D anubis.ANUBIS-0096 anubis.ANUBIS-0001 537 686 B D anubis.ANUBIS-0096 anubis.ANUBIS-0001 766 457 B  | P [anubis.ANUBIS-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0047) [anubis.ANUBIS-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0048) 25 6 B I [anubis.ANUBIS-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0053) NIL 0 590 B P [anubis.ANUBIS-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0057) [anubis.ANUBIS-0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0058) 2 2 B P [anubis.ANUBIS-0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0062) [anubis.ANUBIS-0065](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0065) 245 2 B I [anubis.ANUBIS-0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0070) NIL 5 804 B I [anubis.ANUBIS-0073](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0073) NIL 277 31 B P [anubis.ANUBIS-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0077) [anubis.ANUBIS-0078](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0078) 27 2 B P [anubis.ANUBIS-0092](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0092) [anubis.ANUBIS-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0093) 2 2 B P [anubis.ANUBIS-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0093) [anubis.ANUBIS-0094](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0094) 25 2 B D [anubis.ANUBIS-0096](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0096) [anubis.ANUBIS-0001](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0001) 493 730 B D [anubis.ANUBIS-0096](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0096) [anubis.ANUBIS-0001](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0001) 551 672 B D [anubis.ANUBIS-0096](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0096) [anubis.ANUBIS-0001](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=anubis.ANUBIS-0001) 780 443 B  | An exception in that the repeat lies between many divergent genes. (Other phages generally have parallel genes.)Actually, this isn’t very interesting because those sequences are in a long intergenic area at the end of the genome. |
| Marquardt | P [marquardt.PBI-MARQUARDT-MARQUARDT-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0047) [marquardt.PBI-MARQUARDT-MARQUARDT-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0048) 11 20 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0052) [marquardt.PBI-MARQUARDT-MARQUARDT-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0053) 46 14 B I [marquardt.PBI-MARQUARDT-MARQUARDT-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0057) NIL 710 12 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0063) [marquardt.PBI-MARQUARDT-MARQUARDT-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0064) 8 16 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0068) [marquardt.PBI-MARQUARDT-MARQUARDT-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0069) 15 9 B I [marquardt.PBI-MARQUARDT-MARQUARDT-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0072) NIL 263 45 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0076) [marquardt.PBI-MARQUARDT-MARQUARDT-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0077) 13 16 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0089) [marquardt.PBI-MARQUARDT-MARQUARDT-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0090) 15 16 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0090) [marquardt.PBI-MARQUARDT-MARQUARDT-0091](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0091) 11 16 B U [marquardt.PBI-MARQUARDT-MARQUARDT-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0093) NIL 479 726 B U [marquardt.PBI-MARQUARDT-MARQUARDT-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0093) NIL 537 668 B  | P [marquardt.PBI-MARQUARDT-MARQUARDT-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0047) [marquardt.PBI-MARQUARDT-MARQUARDT-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0048) 25 6 B I [marquardt.PBI-MARQUARDT-MARQUARDT-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0053) NIL 0 590 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0057) [marquardt.PBI-MARQUARDT-MARQUARDT-0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0058) 2 2 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0063) [marquardt.PBI-MARQUARDT-MARQUARDT-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0064) 22 2 B I [marquardt.PBI-MARQUARDT-MARQUARDT-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0069) NIL 5 804 B I [marquardt.PBI-MARQUARDT-MARQUARDT-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0072) NIL 277 31 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0076) [marquardt.PBI-MARQUARDT-MARQUARDT-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0077) 27 2 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0089) [marquardt.PBI-MARQUARDT-MARQUARDT-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0090) 29 2 B P [marquardt.PBI-MARQUARDT-MARQUARDT-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0090) [marquardt.PBI-MARQUARDT-MARQUARDT-0091](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0091) 25 2 B U [marquardt.PBI-MARQUARDT-MARQUARDT-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0093) NIL 493 712 B U [marquardt.PBI-MARQUARDT-MARQUARDT-0093](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=marquardt.PBI-MARQUARDT-MARQUARDT-0093) NIL 551 654 B  |  |
| Phoxy | P [phoxy.PBI-PHOXY-PHOXY-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0047) [phoxy.PBI-PHOXY-PHOXY-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0048) 11 20 B P [phoxy.PBI-PHOXY-PHOXY-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0052) [phoxy.PBI-PHOXY-PHOXY-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0053) 46 14 B I [phoxy.PBI-PHOXY-PHOXY-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0057) NIL 710 12 B P [phoxy.PBI-PHOXY-PHOXY-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0063) [phoxy.PBI-PHOXY-PHOXY-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0064) 8 16 B P [phoxy.PBI-PHOXY-PHOXY-0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0068) [phoxy.PBI-PHOXY-PHOXY-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0069) 15 9 B I [phoxy.PBI-PHOXY-PHOXY-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0072) NIL 263 45 B P [phoxy.PBI-PHOXY-PHOXY-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0076) [phoxy.PBI-PHOXY-PHOXY-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0077) 13 16 B P [phoxy.PBI-PHOXY-PHOXY-0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0085) [phoxy.PBI-PHOXY-PHOXY-0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0086) 11 16 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 505 703 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 563 645 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 782 426 B  | P [phoxy.PBI-PHOXY-PHOXY-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0047) [phoxy.PBI-PHOXY-PHOXY-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0048) 25 6 B I [phoxy.PBI-PHOXY-PHOXY-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0053) NIL 0 587 B P [phoxy.PBI-PHOXY-PHOXY-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0057) [phoxy.PBI-PHOXY-PHOXY-0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0058) 2 2 B P [phoxy.PBI-PHOXY-PHOXY-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0063) [phoxy.PBI-PHOXY-PHOXY-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0064) 22 2 B I [phoxy.PBI-PHOXY-PHOXY-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0069) NIL 5 804 B I [phoxy.PBI-PHOXY-PHOXY-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0072) NIL 277 31 B P [phoxy.PBI-PHOXY-PHOXY-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0076) [phoxy.PBI-PHOXY-PHOXY-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0077) 27 2 B P [phoxy.PBI-PHOXY-PHOXY-0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0085) [phoxy.PBI-PHOXY-PHOXY-0086](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0086) 25 2 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 519 689 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 577 631 B U [phoxy.PBI-PHOXY-PHOXY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=phoxy.PBI-PHOXY-PHOXY-0088) NIL 796 412 B  |  |
| Spike509 | N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 29227 20942 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 32460 17709 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 36124 14045 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 38334 11835 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 40390 9779 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 41601 8568 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 42423 7746 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 47777 2392 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 48523 1646 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49466 703 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49524 645 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49743 426 F  | N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 29241 20928 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 32474 17695 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 36138 14031 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 38348 11821 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 40404 9765 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 41615 8554 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 42437 7732 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 47791 2378 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 48537 1632 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49480 689 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49538 631 F N [spike509.PBI-SPIKE509-SPIKE0509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=spike509.PBI-SPIKE509-SPIKE0509) NIL 49757 412 F  | Data file not very good |
| Farber | P [farber.PBI-FARBER-FARBER-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0047) [farber.PBI-FARBER-FARBER-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0048) 11 20 B P [farber.PBI-FARBER-FARBER-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0052) [farber.PBI-FARBER-FARBER-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0053) 46 14 B I [farber.PBI-FARBER-FARBER-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0057) NIL 710 12 B P [farber.PBI-FARBER-FARBER-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0063) [farber.PBI-FARBER-FARBER-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0064) 8 16 B P [farber.PBI-FARBER-FARBER-0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0068) [farber.PBI-FARBER-FARBER-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0069) 15 9 B I [farber.PBI-FARBER-FARBER-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0072) NIL 263 45 B P [farber.PBI-FARBER-FARBER-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0076) [farber.PBI-FARBER-FARBER-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0077) 13 16 B P [farber.PBI-FARBER-FARBER-0084](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0084) [farber.PBI-FARBER-FARBER-0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0085) 11 16 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 479 713 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 537 655 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 766 426 B  | P [farber.PBI-FARBER-FARBER-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0047) [farber.PBI-FARBER-FARBER-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0048) 25 6 B I [farber.PBI-FARBER-FARBER-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0053) NIL 0 587 B P [farber.PBI-FARBER-FARBER-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0057) [farber.PBI-FARBER-FARBER-0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0058) 2 2 B P [farber.PBI-FARBER-FARBER-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0063) [farber.PBI-FARBER-FARBER-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0064) 22 2 B I [farber.PBI-FARBER-FARBER-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0069) NIL 5 804 B I [farber.PBI-FARBER-FARBER-0072](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0072) NIL 277 31 B P [farber.PBI-FARBER-FARBER-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0076) [farber.PBI-FARBER-FARBER-0077](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0077) 27 2 B P [farber.PBI-FARBER-FARBER-0084](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0084) [farber.PBI-FARBER-FARBER-0085](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0085) 25 2 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 493 699 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 551 641 B U [farber.PBI-FARBER-FARBER-0087](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=farber.PBI-FARBER-FARBER-0087) NIL 780 412 B  |  |
| QuinnKiro | P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0022](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0022) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0023](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0023) 20 97 F P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0015](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0015) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0016](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0016) 20 50 F I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0052) NIL 692 12 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0061) NIL 571 280 B P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0063) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0064) 18 43 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0066](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0066) NIL 326 45 B P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0069) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070) 11 16 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070) NIL 487 307 B U [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089) NIL 13 1122 B U [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089) NIL 383 752 B  | P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0022](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0022) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0023](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0023) 4 113 F P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0015](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0015) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0016](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0016) 4 66 F P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0052) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0053) 2 2 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0061](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0061) NIL 585 266 B P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0063) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0064](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0064) 32 29 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0066](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0066) NIL 340 31 B P [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0069](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0069) [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070) 25 2 B I [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0070) NIL 501 293 B U [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089) NIL 27 1108 B U [quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=quinnkiro.PBI-QUINNKIRO-QUINNKIRO-0089) NIL 397 738 B  |  |
| Tiffany | P [Tiffany.PBI-TIFFANY-TIFFANY-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0047) [Tiffany.PBI-TIFFANY-TIFFANY-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0048) 11 20 B P [Tiffany.PBI-TIFFANY-TIFFANY-0052](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0052) [Tiffany.PBI-TIFFANY-TIFFANY-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0053) 46 14 B I [Tiffany.PBI-TIFFANY-TIFFANY-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0057) NIL 710 12 B P [Tiffany.PBI-TIFFANY-TIFFANY-0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0062) [Tiffany.PBI-TIFFANY-TIFFANY-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0063) 8 16 B P [Tiffany.PBI-TIFFANY-TIFFANY-0067](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0067) [Tiffany.PBI-TIFFANY-TIFFANY-0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0068) 15 9 B I [Tiffany.PBI-TIFFANY-TIFFANY-0071](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0071) NIL 263 27 B P [Tiffany.PBI-TIFFANY-TIFFANY-0075](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0075) [Tiffany.PBI-TIFFANY-TIFFANY-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0076) 13 16 B P [Tiffany.PBI-TIFFANY-TIFFANY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0088) [Tiffany.PBI-TIFFANY-TIFFANY-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0089) 15 16 B P [Tiffany.PBI-TIFFANY-TIFFANY-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0089) [Tiffany.PBI-TIFFANY-TIFFANY-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0090) 11 16 B U [Tiffany.PBI-TIFFANY-TIFFANY-0092](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0092) NIL 479 726 B U [Tiffany.PBI-TIFFANY-TIFFANY-0092](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0092) NIL 537 668 B  | P [Tiffany.PBI-TIFFANY-TIFFANY-0047](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0047) [Tiffany.PBI-TIFFANY-TIFFANY-0048](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0048) 25 6 B I [Tiffany.PBI-TIFFANY-TIFFANY-0053](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0053) NIL 0 590 B P [Tiffany.PBI-TIFFANY-TIFFANY-0057](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0057) [Tiffany.PBI-TIFFANY-TIFFANY-0058](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0058) 2 2 B P [Tiffany.PBI-TIFFANY-TIFFANY-0062](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0062) [Tiffany.PBI-TIFFANY-TIFFANY-0063](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0063) 22 2 B I [Tiffany.PBI-TIFFANY-TIFFANY-0068](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0068) NIL 5 804 B I [Tiffany.PBI-TIFFANY-TIFFANY-0071](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0071) NIL 277 13 B P [Tiffany.PBI-TIFFANY-TIFFANY-0075](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0075) [Tiffany.PBI-TIFFANY-TIFFANY-0076](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0076) 27 2 B P [Tiffany.PBI-TIFFANY-TIFFANY-0088](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0088) [Tiffany.PBI-TIFFANY-TIFFANY-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0089) 29 2 B P [Tiffany.PBI-TIFFANY-TIFFANY-0089](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0089) [Tiffany.PBI-TIFFANY-TIFFANY-0090](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0090) 25 2 B U [Tiffany.PBI-TIFFANY-TIFFANY-0092](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0092) NIL 493 712 B U [Tiffany.PBI-TIFFANY-TIFFANY-0092](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=Tiffany.PBI-TIFFANY-TIFFANY-0092) NIL 551 654 B  |  |

## Genome location percentages

A graph of these numbers is located above in the [Results section](#_Location_of_the). Each group of rows consists of the phage name, then the start coordinate of a repeat, then the genome location (zoom in to view):

[mycobacterium\_phage\_bxz2](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_bxz2)

30071 33304 36968 39178 41234 42445 43267 48541 49287 50204 50262

59.0635 65.41355 72.61014 76.950874 80.989136 83.36771 84.98222 95.34107 96.80632 98.60743 98.72135

[mycobacterium\_phage\_jhc117](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_jhc117)

30031 33265 36932 39142 41198 42409 43230 48503 49249 50166 50224

59.026672 65.38318 72.59076 76.93457 80.975685 83.355934 84.969635 95.33385 96.800125 98.60251 98.716515

[mycobacterium\_phage\_microwolf](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_microwolf)

30034 33267 36949 39159 41215 42426 43248 48602 49348 50162 50220 50439

59.047657 65.403824 72.64273 76.987656 81.02981 83.41067 85.02674 95.55285 97.0195 98.61985 98.73388 99.16444

[mycobacterium\_phage\_rockstar](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_rockstar)

14501 11982 37344 39470 40369 41614 42348 42851 45551 46643 47020 47100

30.349518 25.077438 78.158226 82.60779 84.48933 87.09502 88.631226 89.68397 95.33487 97.620346 98.40938 98.57681

[mycobacterium\_phage\_vix](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_vix)

30115 33349 37016 39226 41282 42493 43315 48588 49334 50251 50309

59.09189 65.43767 72.63309 76.96957 81.00387 83.3801 84.993034 95.33976 96.803566 98.602905 98.71671

[mycobacterium\_phage\_heldan](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_heldan)

14633 12134 37781 39930 40835 42077 42808 43311 49235 49605 49685

29.054483 24.092606 75.015884 79.28282 81.07974 83.545784 84.99722 85.99595 97.758316 98.49297 98.65182

[mycobacterium\_phage\_methuselah](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_methuselah)

30060 33293 36957 39167 41223 42434 43256 48529 49275 50192 50250 50479

59.067417 65.42021 72.61991 76.962524 81.00253 83.38213 84.997345 95.35871 96.824585 98.62647 98.74045 99.19043

[mycobacterium\_phage\_jobu08](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_jobu08)

29865 33098 36765 38975 41031 42242 43063 48413 49159 49975 50033 50252

58.929733 65.309105 72.54484 76.905624 80.96253 83.35208 84.97208 95.52872 97.00073 98.61086 98.72531 99.15744

[mycobacterium\_phage\_phantastic](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_phantastic)

14546 37512 39638 40543 41791 42525 43028 48955 49329 49409

29.033352 74.87276 79.11619 80.92254 83.413506 84.87855 85.882515 97.71262 98.459114 98.61879

[mycobacterium\_phage\_anubis](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_anubis)

29930 33164 36831 39041 41097 42308 43130 48489 49235 50152 50210 50439

58.852448 65.21158 72.422134 76.76774 80.810524 83.19176 84.80808 95.34568 96.81257 98.6157 98.729744 99.18004

[mycobacterium\_phage\_marquardt](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_marquardt)

30034 33268 36935 39145 41201 42412 43234 48507 49253 50170 50228

59.026768 65.38265 72.58952 76.93291 80.973625 83.353645 84.96915 95.33234 96.79848 98.600685 98.714676

[mycobacterium\_phage\_phoxy](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_phoxy)

30061 33294 36958 39168 41224 42435 43257 47635 48578 48636 48855

61.016502 67.578705 75.01573 79.501495 83.67467 86.132706 87.80116 96.68744 98.6015 98.71922 99.16374

[mycobacterium\_phage\_spike509](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_spike509)

30061 33294 36958 39168 41224 42435 43257 48611 49357 50300 50358 50577

58.955853 65.29644 72.4823 76.81657 80.84881 83.22383 84.835945 95.33625 96.79931 98.64873 98.76248 99.191986

[mycobacterium\_phage\_farber](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_farber)

30026 33259 36923 39133 41189 42400 43222 47574 48491 48549 48778

61.040863 67.613335 75.062004 79.55479 83.7345 86.19638 87.867455 96.71478 98.57898 98.69689 99.16243

[mycobacterium\_phage\_quinnkiro](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_quinnkiro)

15134 12630 36708 40000 40878 42129 42842 43345 48958 49328

30.2281 25.2267 73.31922 79.89454 81.648224 84.14693 85.571045 86.57572 97.78692 98.52595

[mycobacterium\_phage\_tiffany](http://biobike-9003.csbc.vcu.edu/frame-editor?pkg=GARGA439955&name=mycobacterium_phage_tiffany)

29918 33152 36819 39029 41085 42296 43117 48393 49139 50056 50114

58.930824 65.30098 72.52403 76.87717 80.92696 83.312325 84.92948 95.32185 96.79128 98.59754 98.711784