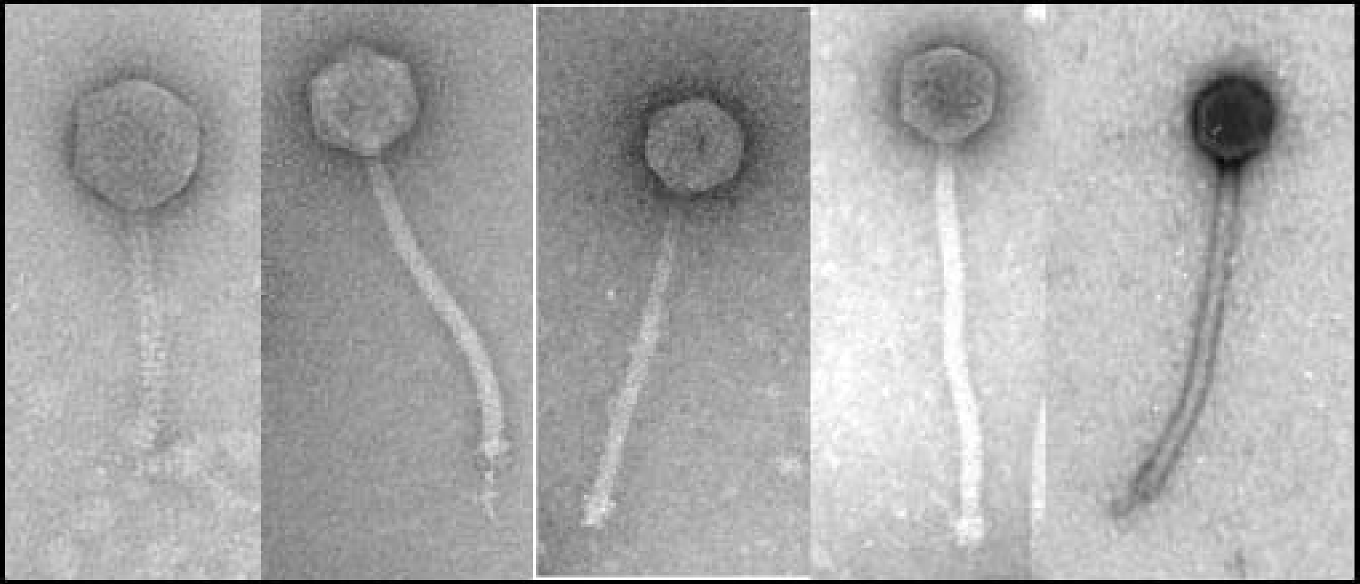
# Bacteriophages: Genes and Genomes

## Part 2. Bacteriophages: Genomic insights

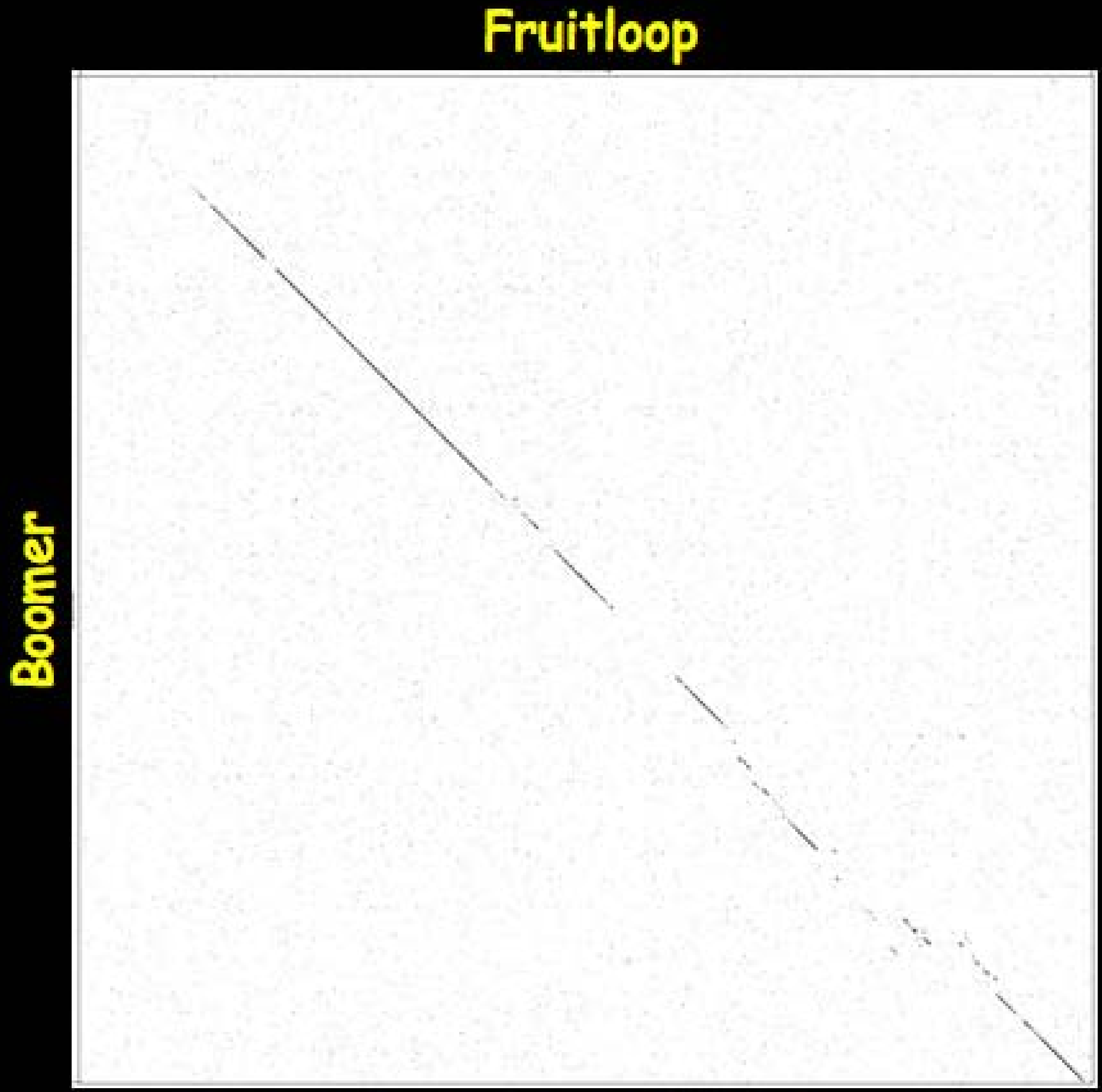
Graham F. Hatfull
University of Pittsburgh

# Bacteriophage genomes and genome evolution

Virion morphology does not necessarily reflect evolutionary relationships



# Phage genomics reveals evolutionary histories and mechanistic insights

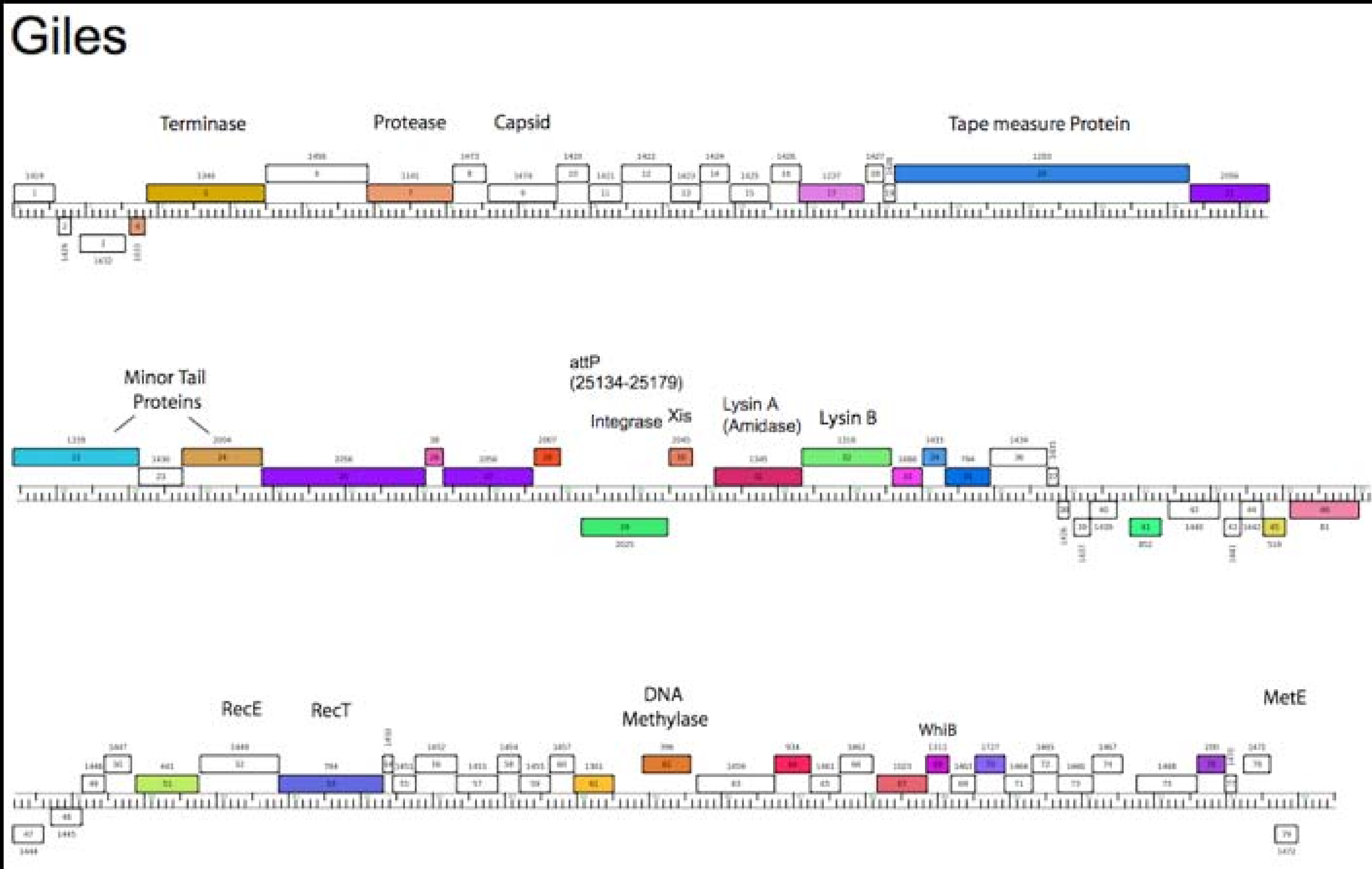



Dotplot comparison of Fruitloop and Boomer genomes

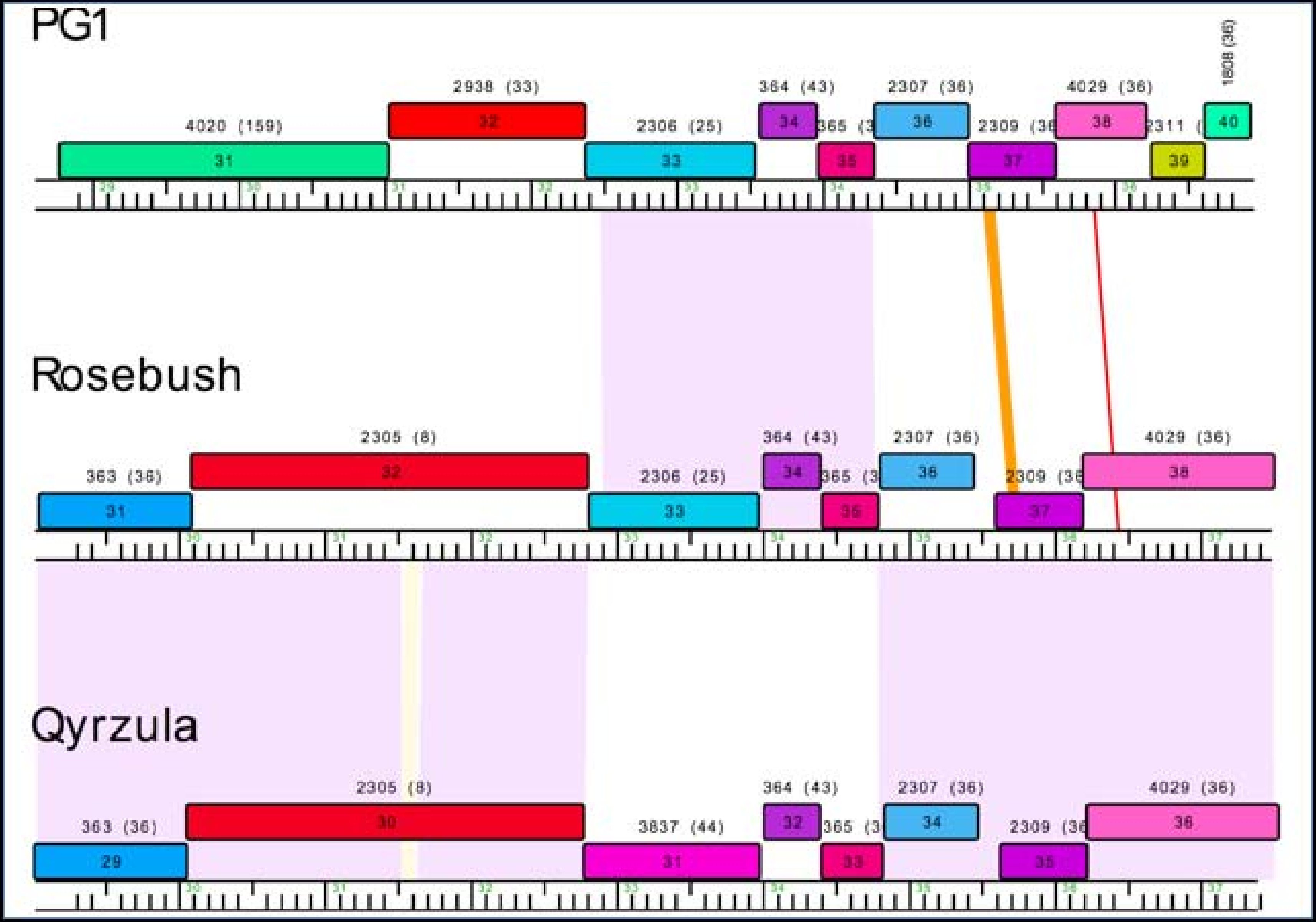
# What do phage genomes look like?

1. Phage DNA isolated from virions is linear
2. Genome have either defined or terminally redundant circularly permuted ends
3. Size range: ~ 5 – 500 kbp
4. Phage genomes are densely packed with genes
5. Phages infecting bacteria from different genera are typically unrelated at DNA level

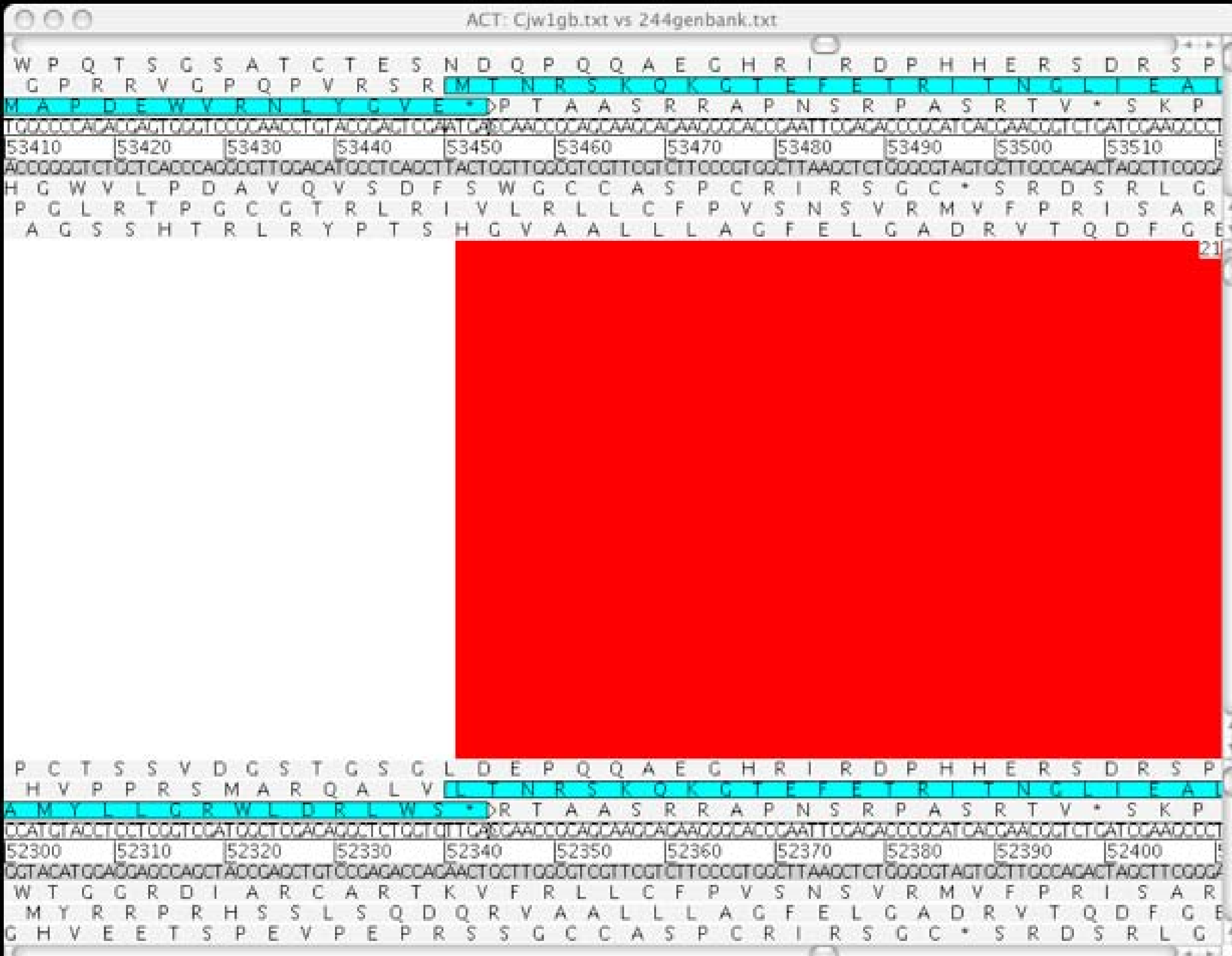
# Bacteriophage genome organization



# The characteristic architectural feature: mosaicism



# Module boundaries correspond with gene boundaries



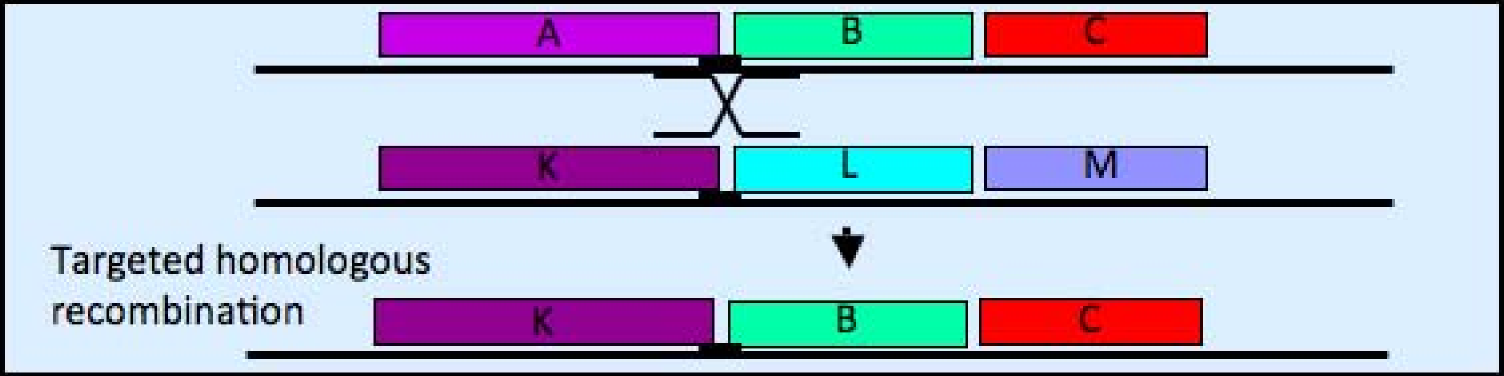
# How does genomic mosaicism arise?

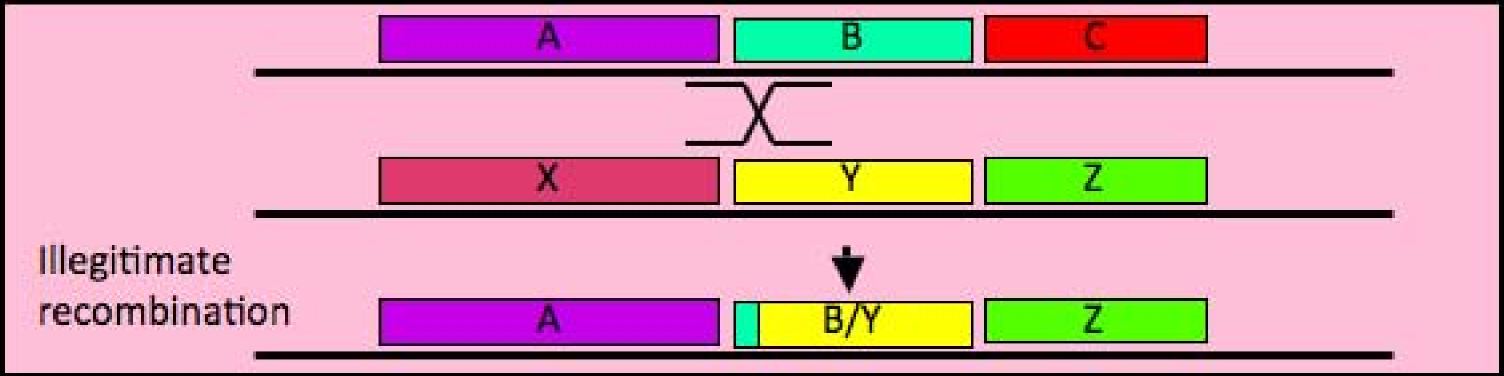
Two models:

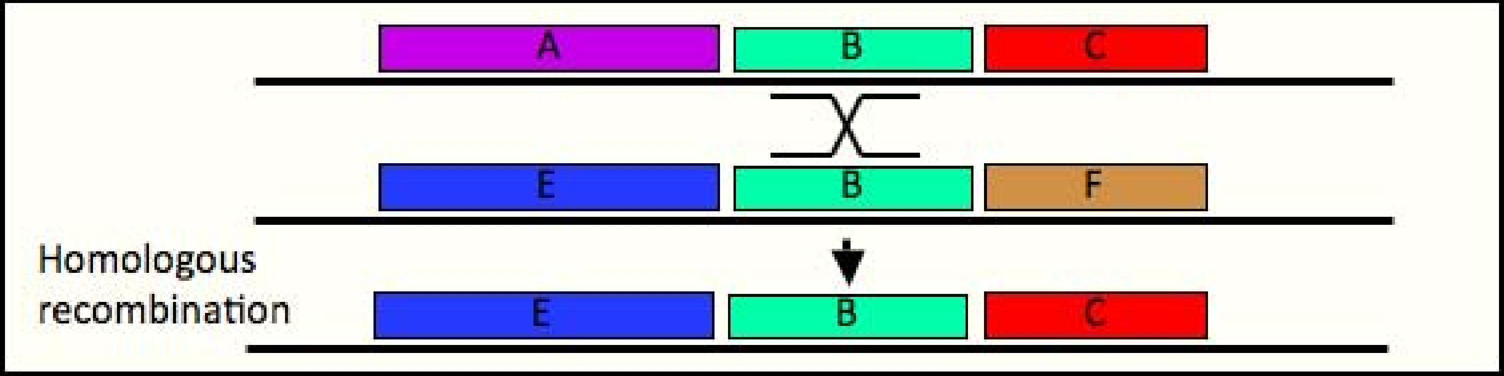
1. By targeting of homologous recombination to conserved boundary sequences

2. By illegitimate recombination at random sequences

# How does genomic mosaicism arise?



# Proposed role of illegitimate recombination has important consequences

1. Illegitimate recombination happens at low frequency

2. Occurs at random positions

3. Most recombination events generate genomic trash

4. Multiple low frequency events are likely needed to generate survivors

# Proposed role of illegitimate recombination has important consequences

4. Phage genomes will recombine with the bacterial chromosome

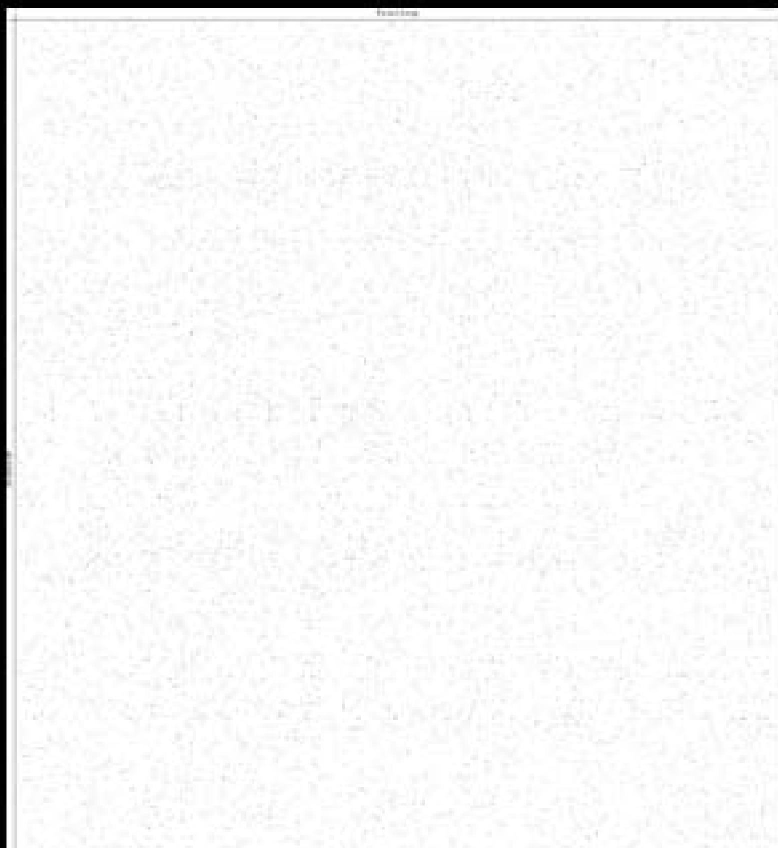
5. It is highly creative: joining DNA segment not previously joined

6. Recombinant joints can survive as fossilized relics of recombination

7. Many phages encode recombinases that could facilitate recombination between very short sequences

# Zooming in on phage genome comparisons

Because phages of distantly-related bacteria
are very different to each other……



It is harder to learn about how they evolved

# In conclusion…

- Phage genomes are architecturally mosaic
- Mosaicism is fueled by illegitimate recombination
- Genome segments can be re-assorted by homologous recombination