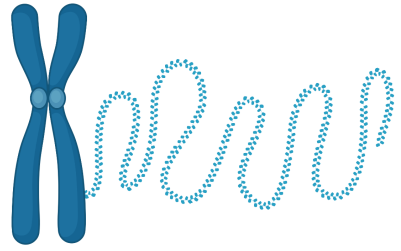


Evolution of Homologous Recombination Rates Across Bacteria

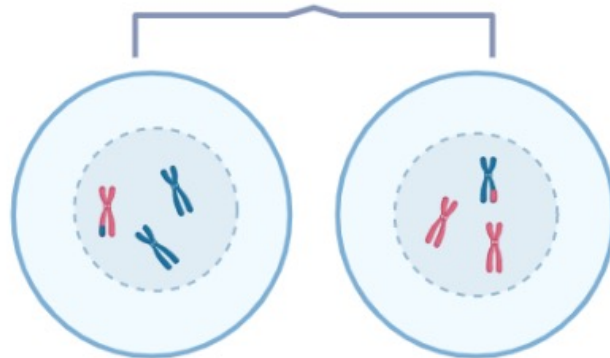
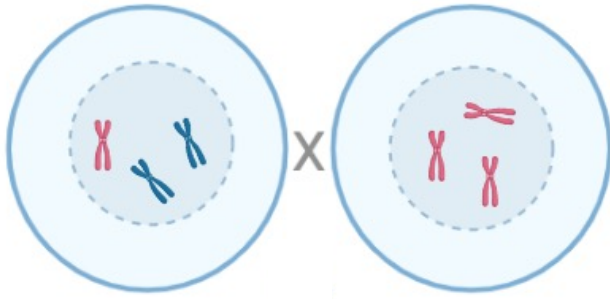
Ellis Torrance, PhD
2024 DOE CSGF Program Review

Let's Chat! eltorra@sandia.gov

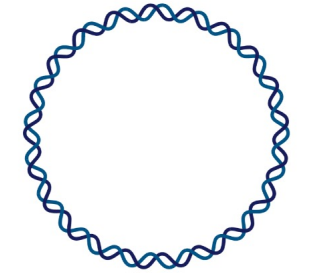
Typical Eukaryotes



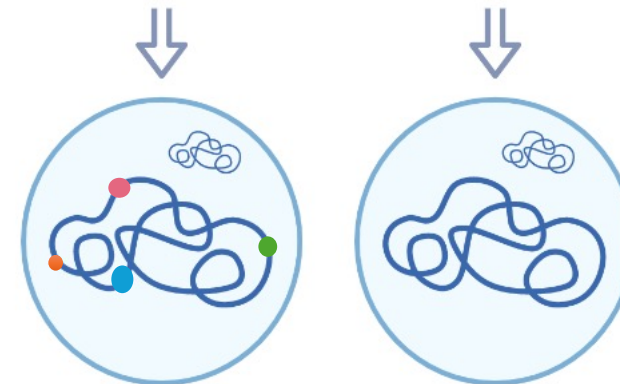
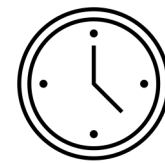
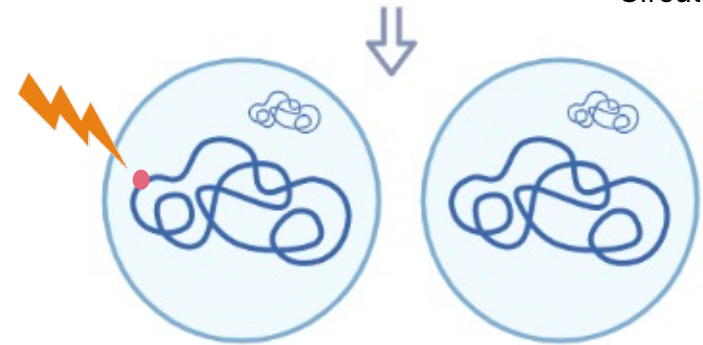
Linear Chromosome



Bacteria



Circular Chromosome

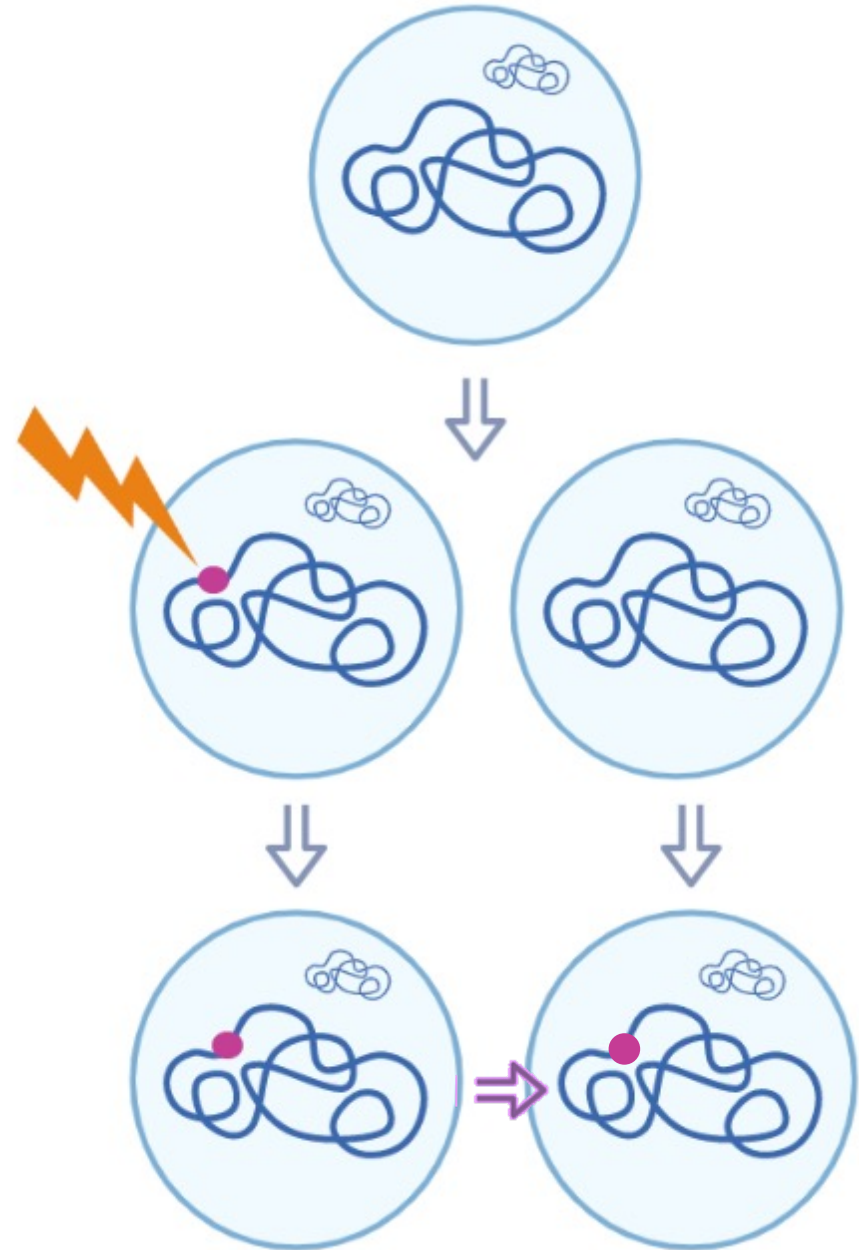


Species A

Species B

Lateral Genetic Transfer – Genetic information is transferred between individuals outside of contemporary parent to offspring inheritance

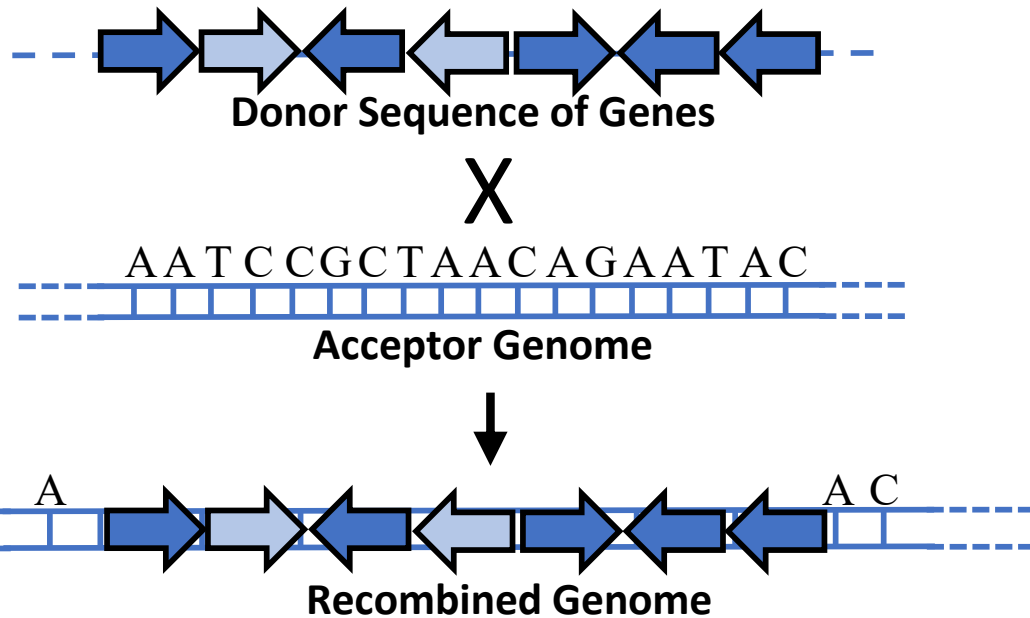
- Change is heritable
- Homologous recombination or Horizontal gene transfer



Lateral Genetic Transfer

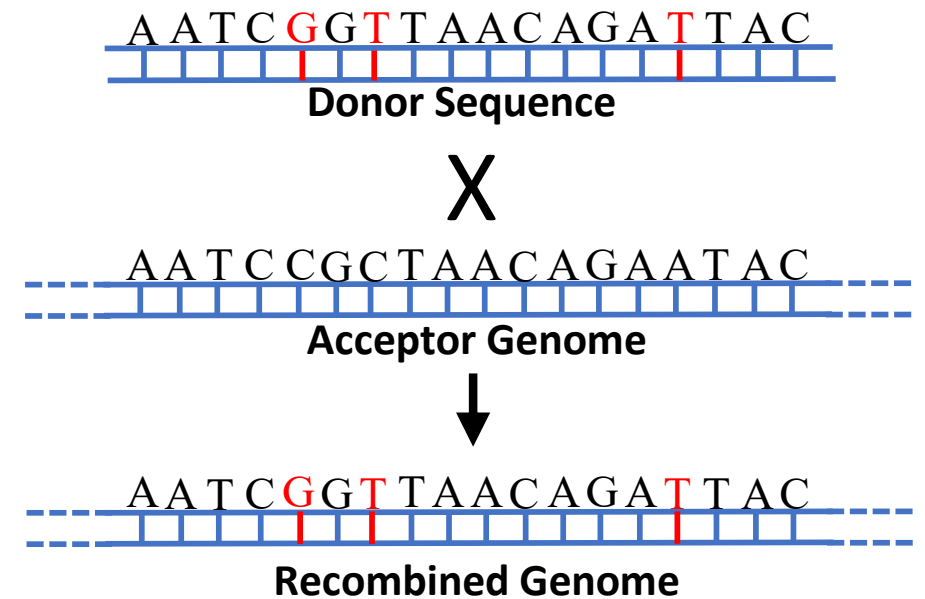
Horizontal Gene Transfer

- Large gene or multi-gene fragments
- Can occur between species, genera, kingdoms
- No requisite of homology



Homologous Recombination

- ~95% DNA Identity
- Small DNA exchanges (<1k bp)
- Occurs primarily within a species
- Quantify with r/m



Homologous Recombination primarily occurs in the core genome

Members of a Bacterial Species



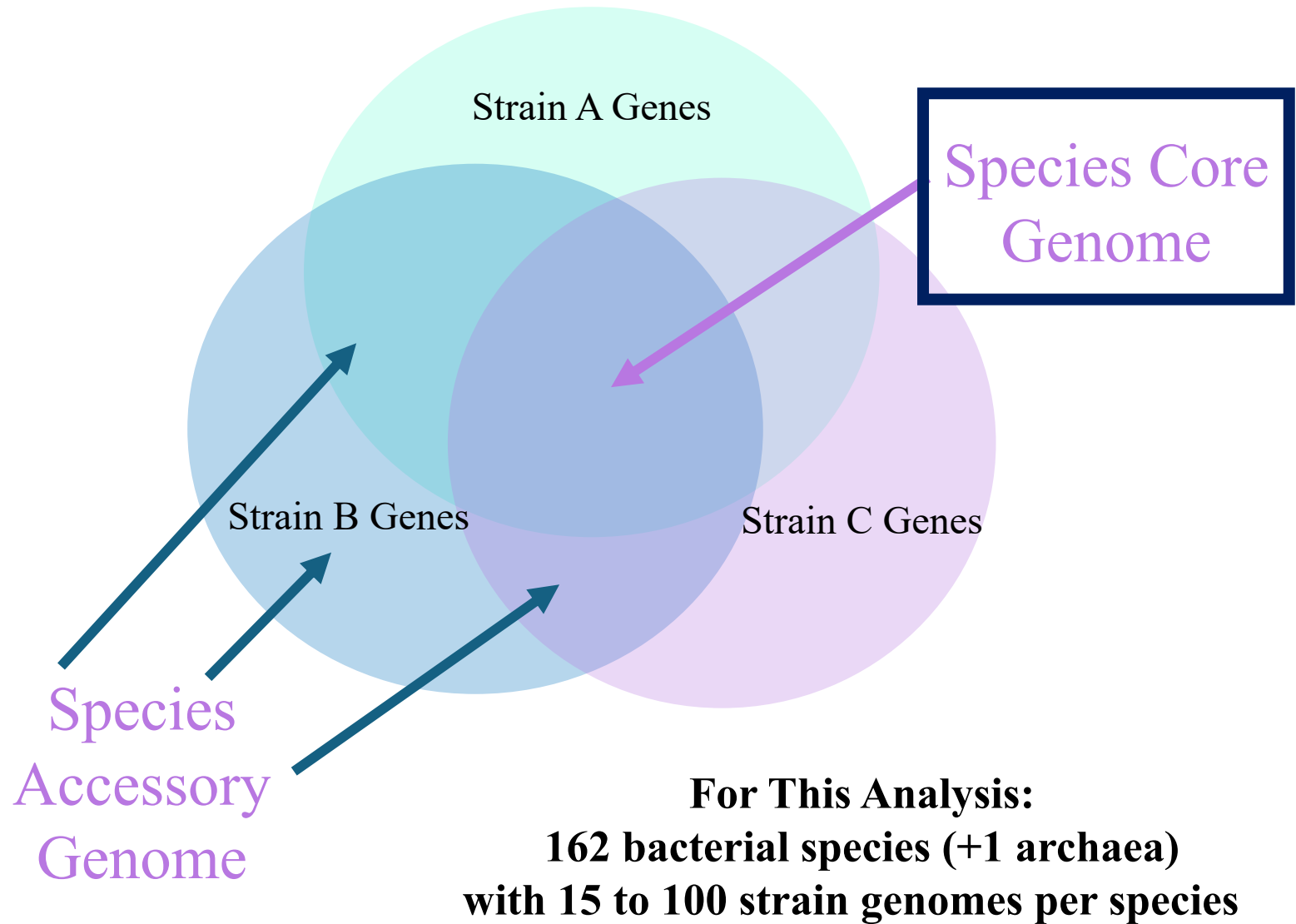
Strain A

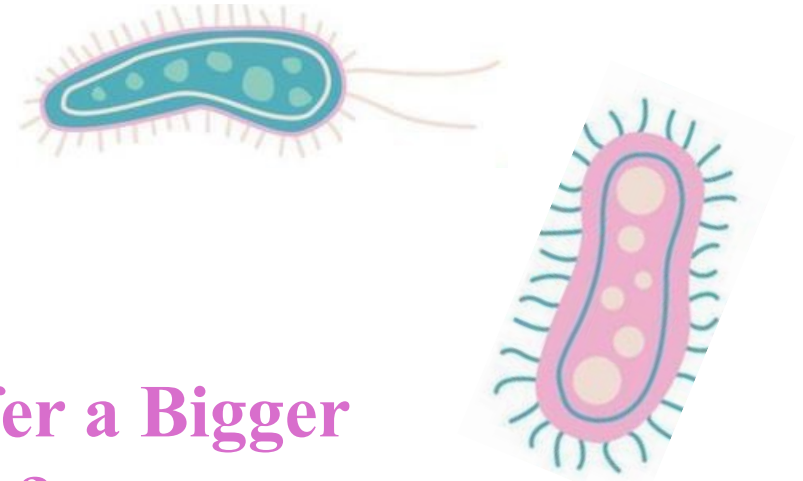


Strain B



Strain C





Big Evolutionary Question:

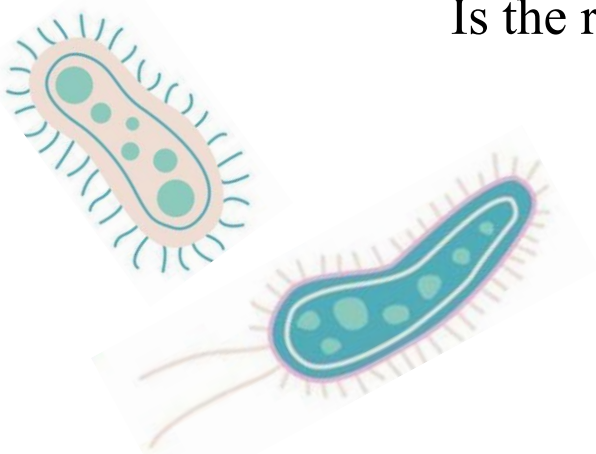
Is Mutation or Lateral Genetic Transfer a Bigger Driver of Bacterial Evolution?

What imparts more diversity: Mutation or Homologous Recombination?

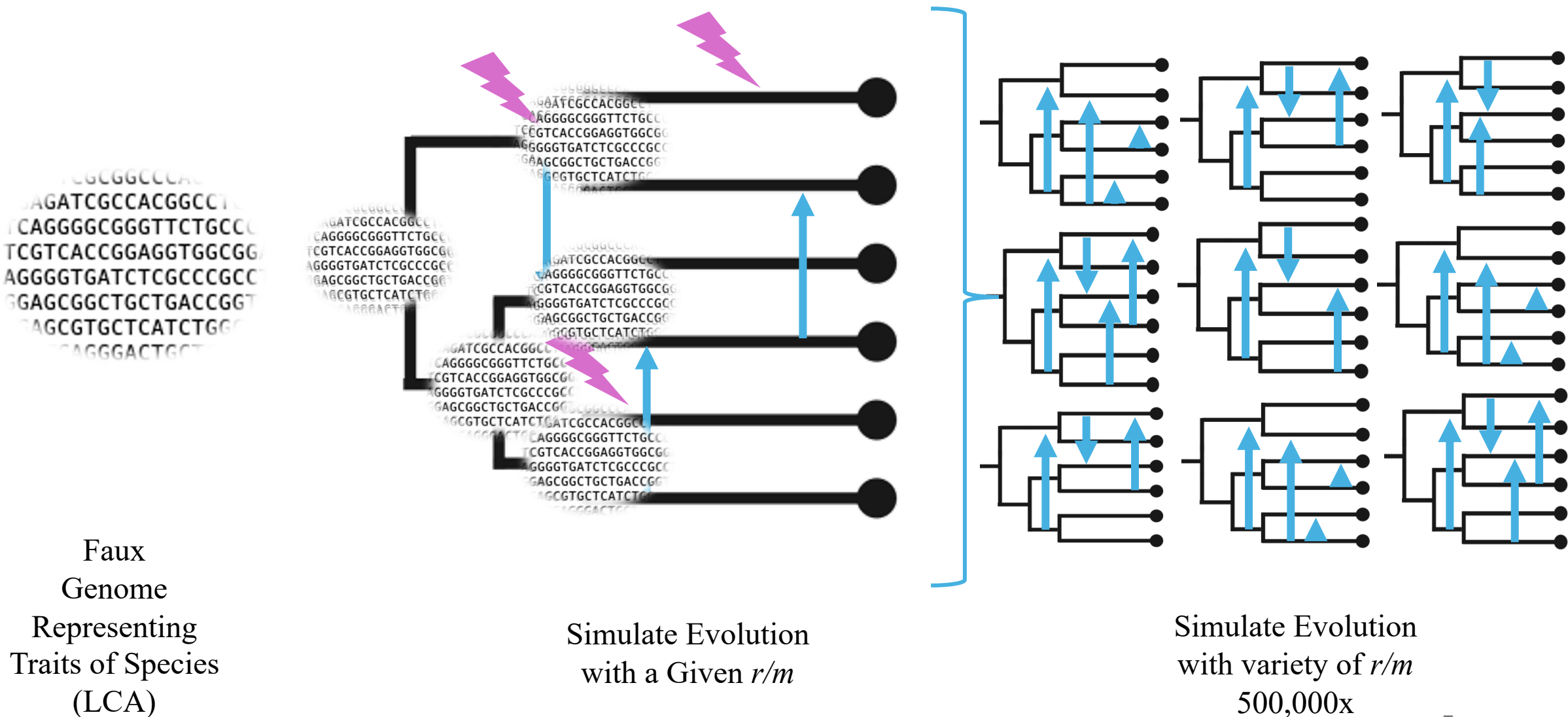
Is this ratio different for different species, genera, etc?

If so, how has this trait evolved and what factors might impact its evolution?

Is the relative contribution different for different genes and genomic sites?

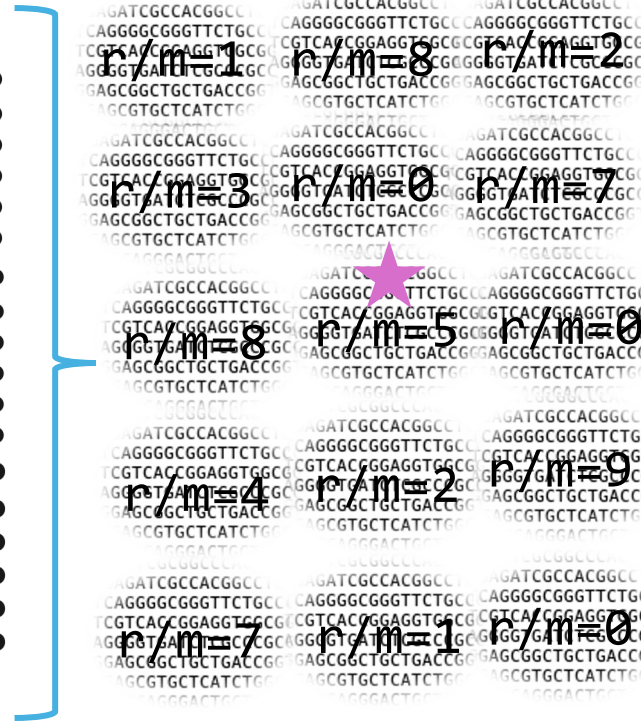
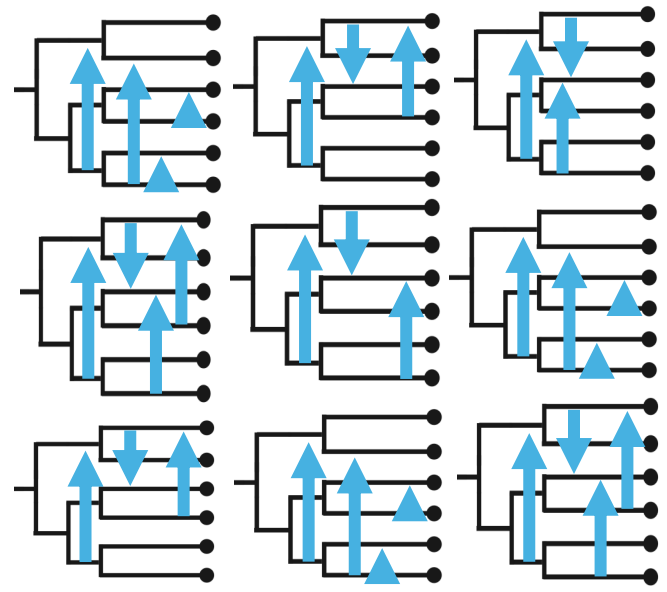


recABC: Novel Method for Inferring Homologous Recombination Rates Using Approximate Bayesian Computation



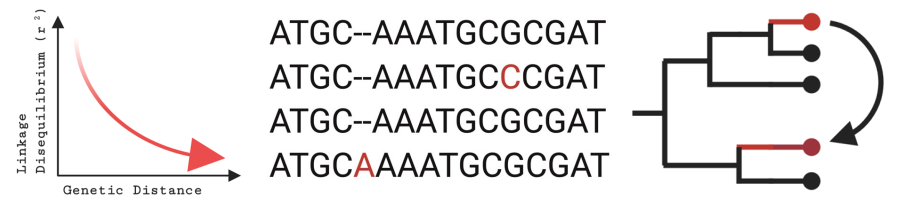
recABC: Novel Method for Inferring Homologous Recombination Rates Using Approximate Bayesian Computation

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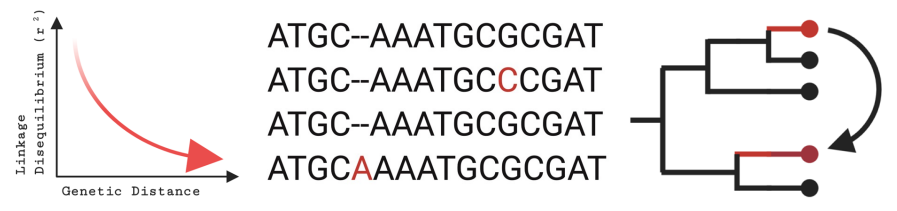


★ Actual Species Core Genome

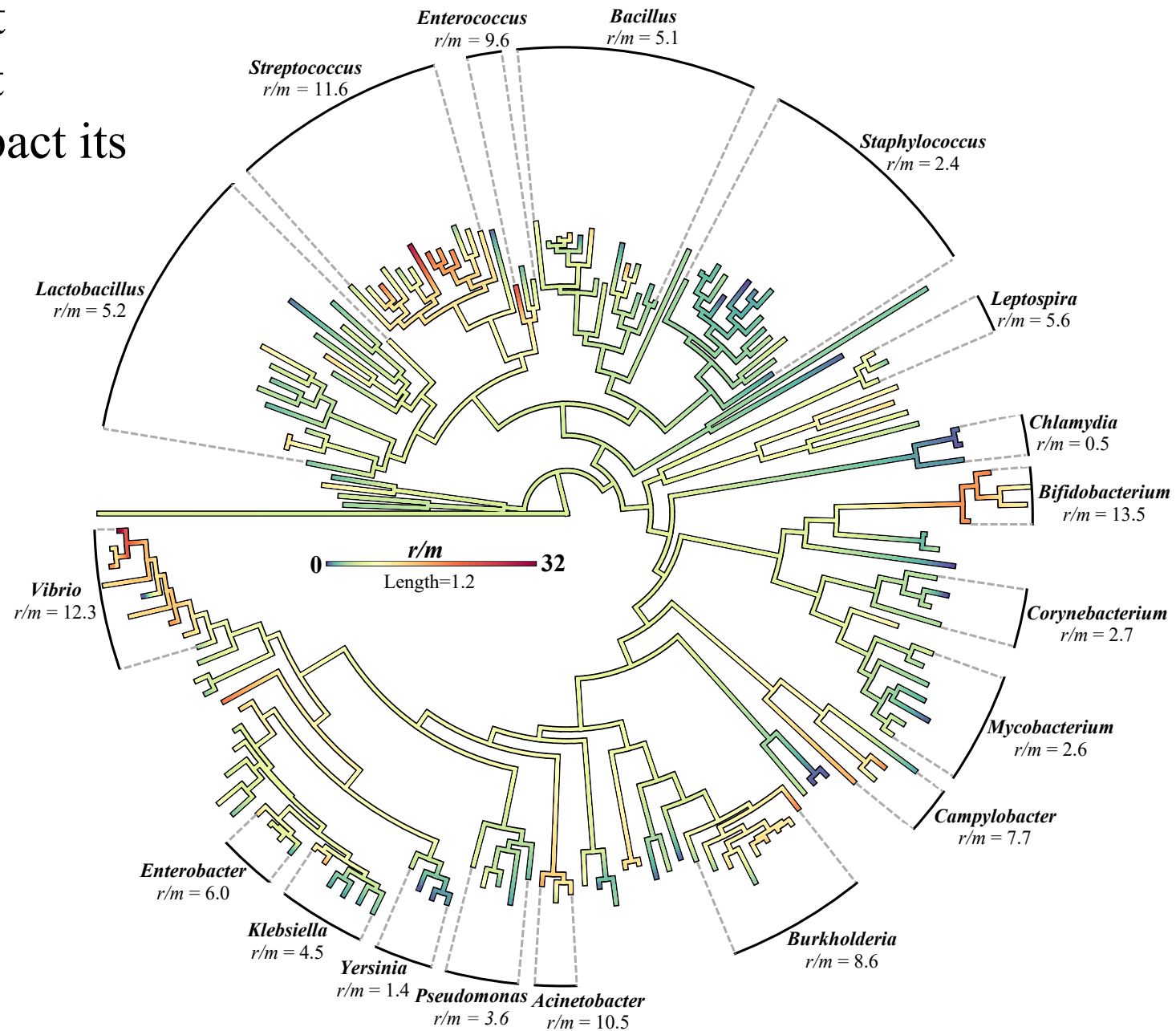
>500k Simulated Species Core Genomes Evolved Under Different r/m



ABC
 =



How has this trait evolved and what factors might impact its evolution?



Is Mutation or Lateral Genetic Transfer a Bigger Driver of Bacterial Evolution?



Lateral Genetic Transfer!



What imparts more diversity: Mutation or Homologous Recombination?

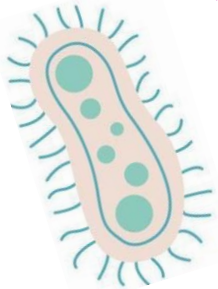
Is this ratio different for different species, genera, etc?

If so, how has this trait evolved and what factors might impact its evolution?

HR contributes ~6x more diversity than mutation alone

Varies from $r/m < 1$ to $r/m > 30$

Evolutionary conservation at genus level indicates recombination rate is an evolvable trait. Limited data supports r/m impacted by likelihood of interaction with variant cells of same species.



Is Mutation or Lateral Genetic Transfer a Bigger Driver of Bacterial Evolution?



Lateral Genetic Transfer!

Cool.

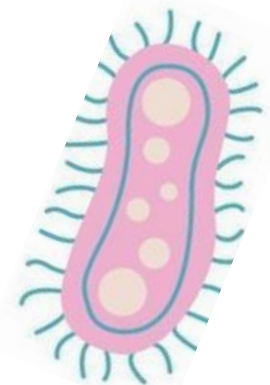
Update Current Models of Evolution

(Most) bacterial species populations are a collection of unique individuals, not clones

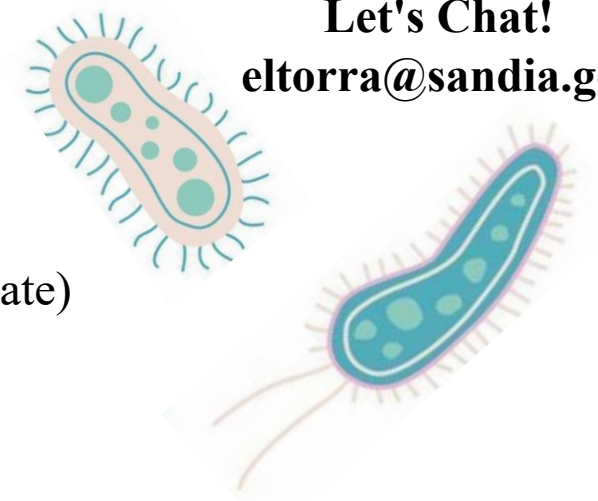
Enhance Prediction of: AMR acquisition and spread

Pathogenicity & Disease Change in Response to Environmental Stress

...And more!

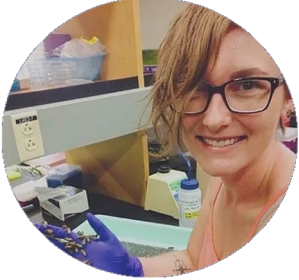


Let's Chat!
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