Discussion Club 2018-09-04:

Soil-persistent *E. coli* and Mobile elements

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Outline

Background

What does 10 years look like to *E. coli*?

Mobile Genetic Elements

In Closing

Background

Project Overview

- *E. coli* has been found to persist stably in the soil
- Isolates were cultured from lysimeter leachate
- Strains were sequenced, resulting in 149 soil-persistent *E. coli* genome

Research Questions

- What types of *E. coli* are able to persist in soil?

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- What types of *E. coli* are able to persist in soil?
- What virulence factors are harboured by these strains?
- What can we infer about adaptation from these?
- Can we differentiate soil-persistent *E. coli* from recent contamination?

What does 10 years look like to *E. coli*?

BoE Calculations for Doubling Time

(5.9 / 2) * 365.25 * 10

≈ 10k generations

Bååth 1998

(assuming generation time roughly equals half of turnover rate)

Other estimates

- 32 days
- 22 days
- 8 weeks
- 114 days

Detection of Escherichia coli is sequenced soil

Escherichia coli approximately .092% prevelence in soil

Hypotheses

Highly diverse soil communities and environmental pressures favour rapid adaptation over incremental changes

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Adaptations will occur more rapidly because of mobile elements rather than mutations to core functions

Mobile Genetic Elements

Insertion Sequence (IS) (Transposon)

Short, mobile sequence capable of jumping

- Size: 750bp – 1.5Kb
- Detection: inverted tandem repeat lollipop with a transposase and promoter.
- Maintenence: genome replication
- Mobility: encoded transposase

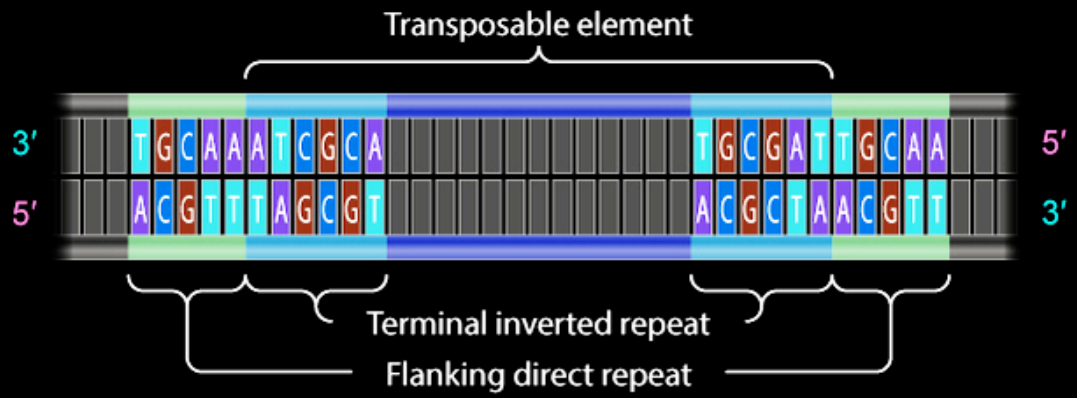


Figure: Insertion Sequence

Non-Composite Transposon

A DNA lolipop containing a transposase and promoter, and other accessory genes

- Size: < 3Kb
- Detection: inverted tandem repeat, transposase, bonus genes
- Maintenence: genome replication
- Mobility: encoded transposase

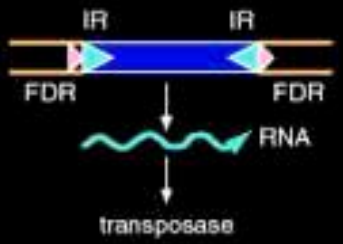
Composite Transposon

A DNA fragment with IS sequences on each end

- Size: < 5Kb
- Detection: double IS, promoters, and accessory genes
- Maintenence: genome replication
- Mobility: encoded transposase

Review

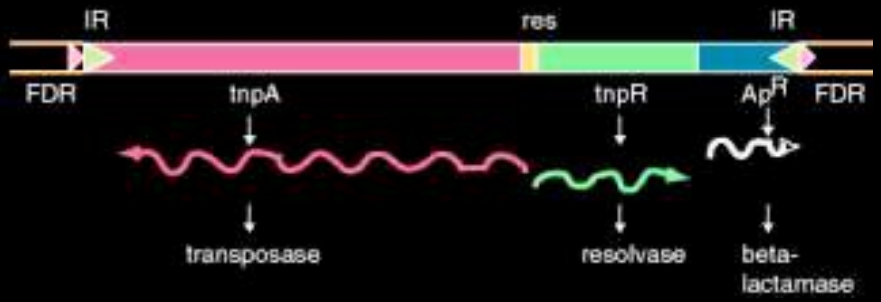
Insertion sequences



Transposons

Composite transposons, e.g. Tn5

Transposons lacking terminal ISs, e.g. TnA



Integrons

Mini-plasmids often containing AMR gene cassettes

- Size: < 10Kb
- Detection: integrase, recombination site (attI), promoter, and (optionally) a cassette of resistence genes
- Maintenance: integration into host genome
- Mobility: recombination, or transfer when circularized

Genetic (Chromosomal) Islands

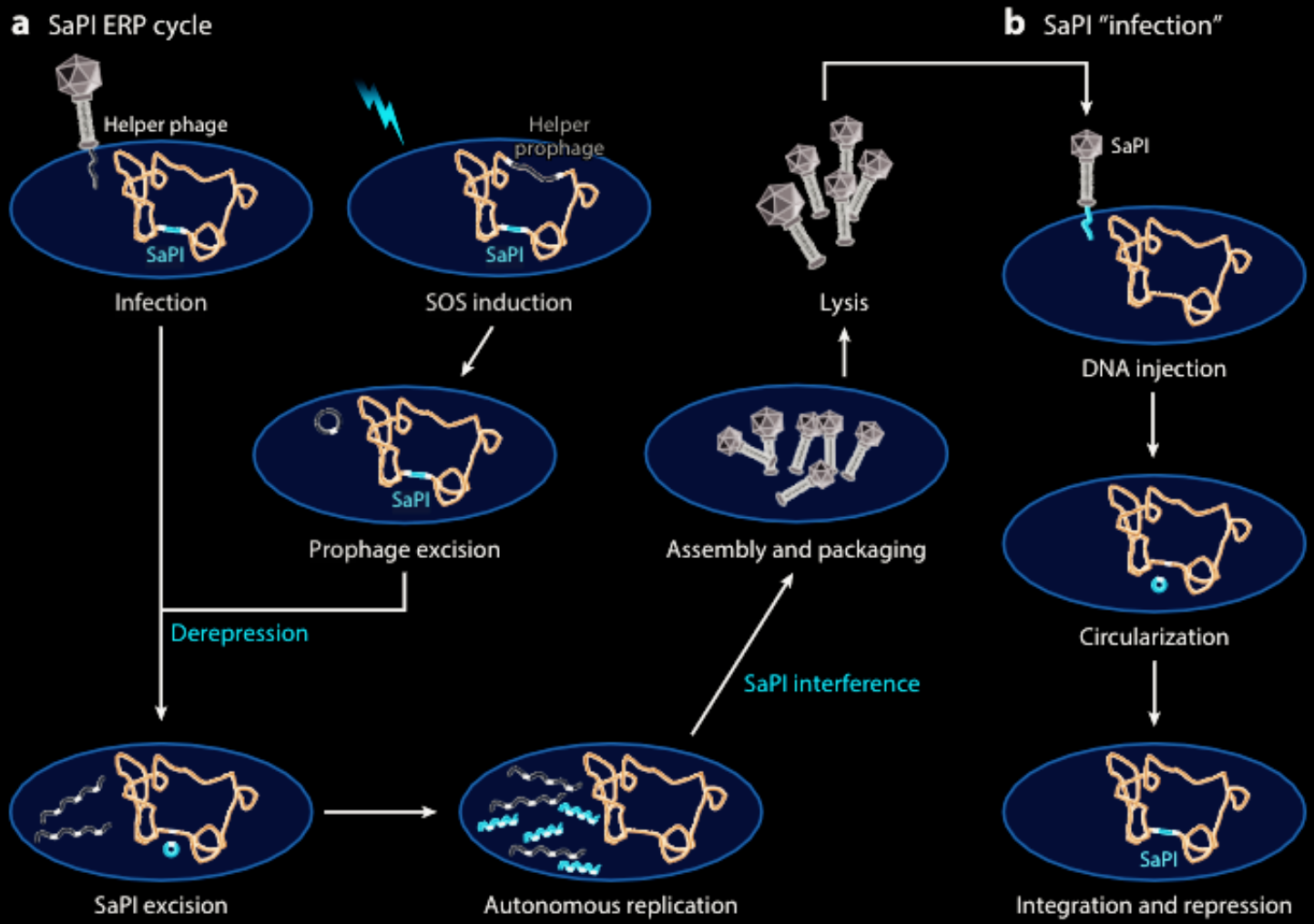
- Size: >10Kb
- Detection: GC Skew, phylogenetic analysis of ORFs
- Maintenence: genome replication
- Mobility: various

Phage-inducible Chromosomal Islands

Phage parasites

- Size: 5 – 15Kb
- Detection: Look for phage proteins along with phage inhibitors
- Maintenence: lysogeny
- Mobility: phage-like particles

Phage-inducible Chromosomal Islands



Prophages

Virus integrated into the host genome

- Size: ~ 50Kb
- Detection: Look for phage integrases, tail and capsule proteins
- Maintenence: genome replication
- Mobility: lysogenic and lytic phases

Plasmids

Freely replicating DNA not required for survival

- Size: <1Kb – 1Mb
- Detection: run a gel; look for circular contigs
- Maintenence: self-replicating or integrating
- Mobility: conjugation (directly or indirectly)

In Closing

Future plans

- Develop mobile pangenome tool for detecting "recent" adaptations
- Characterize trends in MGEs in environmental vs enteric *E. coli*

Sources

- https://www.nature.com/scitable/topicpage/transposons-the-jumping-genes-518
- https://www.nature.com/scitable/topicpage/transposons-the-jumping-genes-518
- https://www.researchgate.net/publication/283707425_The_Phage-Inducible_Chromosomal_Islands_A_Family_of_Highly_Evolved_Molecular_Parasites
- https://www.sciencedirect.com/science/article/pii/S0043135416302226
- http://www.bx.psu.edu/~ross/workmg/TranspositionCh9_files/

Acknowledgments

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- Dr. Fiona Brennan
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Questions?