Agrobacterium fabrum's Ribosomes: general mRNA readers or specialized translators

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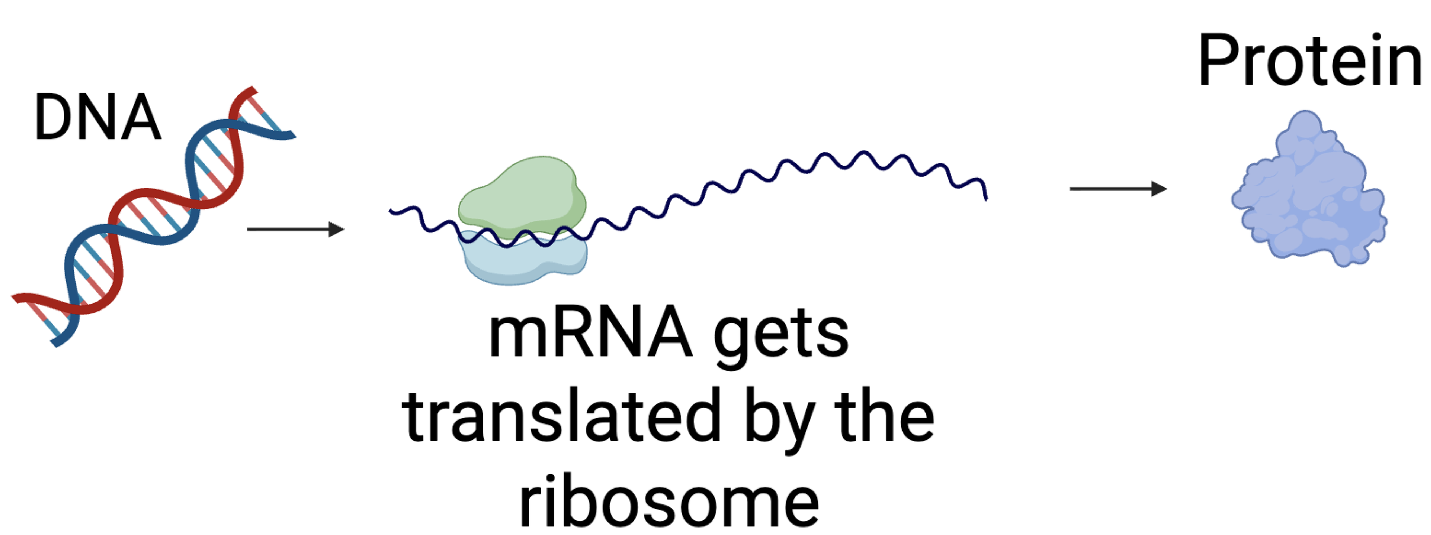
Abstract

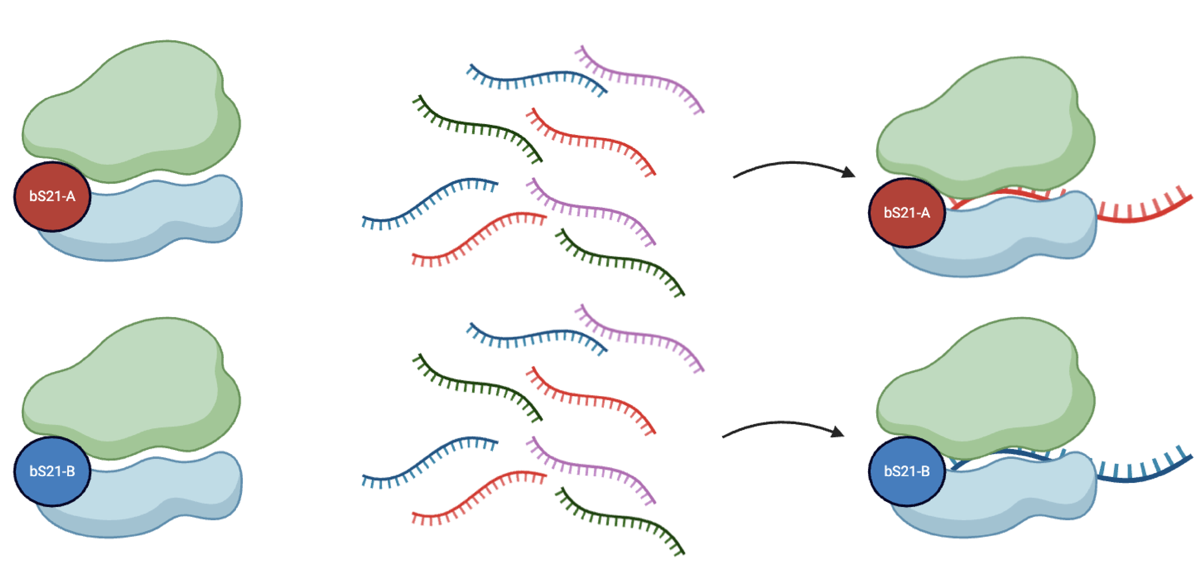
Ribosomes are the essential enzymes in all cells that read mRNA blueprints and translate them into proteins. Ribosomes within a cell are traditionally considered identical in their makeup and job; however, there is growing evidence that ribosomes can be made up of unique parts. This results in a subpopulation that may differ functionally. Scientists disagree as to whether these assorted makeups change how the ribosome acts[1-3]. Some argue that unique ribosomes read mRNA differently or prefer to read certain mRNA over others, leading to altered levels of proteins based on the type of ribosome. Changing the behavior of a ribosome can be beneficial for the cell or destructive, as alterations to ribosome makeup cause many diseases. These diseases, termed ribosomopathies, are often caused by mutations in ribosomal proteins (RPs) that prevent ribosomes from properly functioning[4]. Understanding how ribosome diversity affects cellular function in different cell types and situations will help give more insight into these diseases that are caused by a range of mutations. We use the model organism *Agrobacterium fabrum* to help investigate how changes in RPs change the ribosome's behavior. *A. fabrum* is most known for its ability to cause crown gall disease in plants by inserting specific DNA into the plant's cells. The DNA is incorporated into the plant's DNA, causing the plant to grow a tumor and produce food for *A. fabrum*, which now makes a home in the tumor[5]. *A. fabrum* also encodes three different types of the RP bS21, which we refer to as bS21-A, -B, and -C[6]. These similar but unique proteins can each get incorporated into the ribosome, but it is unknown if a ribosome containing bS21-A behaves differently from one containing bS21-B or -C. We hypothesize that the incorporation of a different bS21 changes the ribosomes' behavior. Our recent data shows that ribosomes containing bS21-B fail to translate certain genes, while ribosomes containing bS21-A and –C are functionally the same.

Introduction

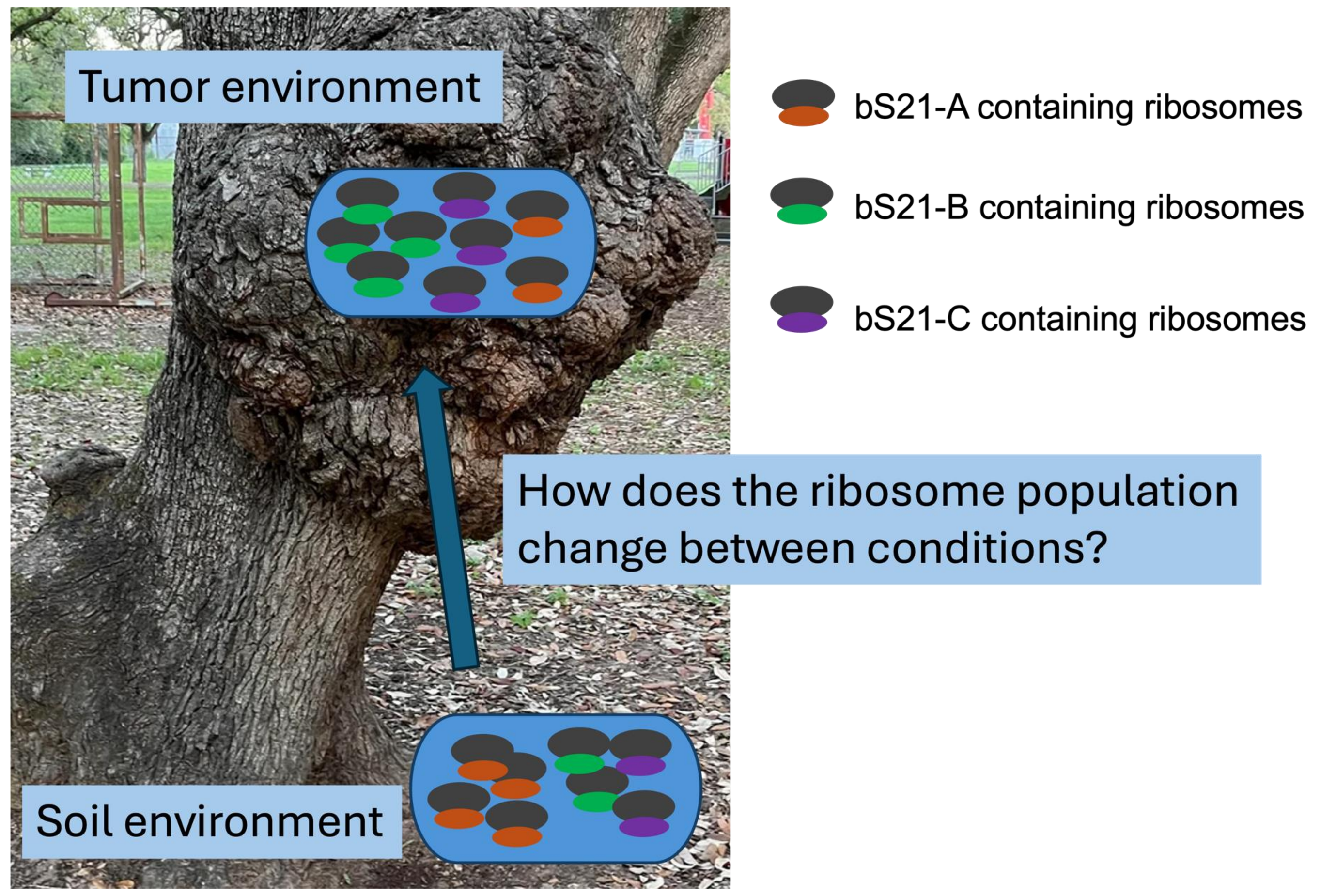
DNA is transcribed into mRNA, which the ribosome translates into proteins



Do different bS21 proteins cause the ribosome to prefer certain mRNA?



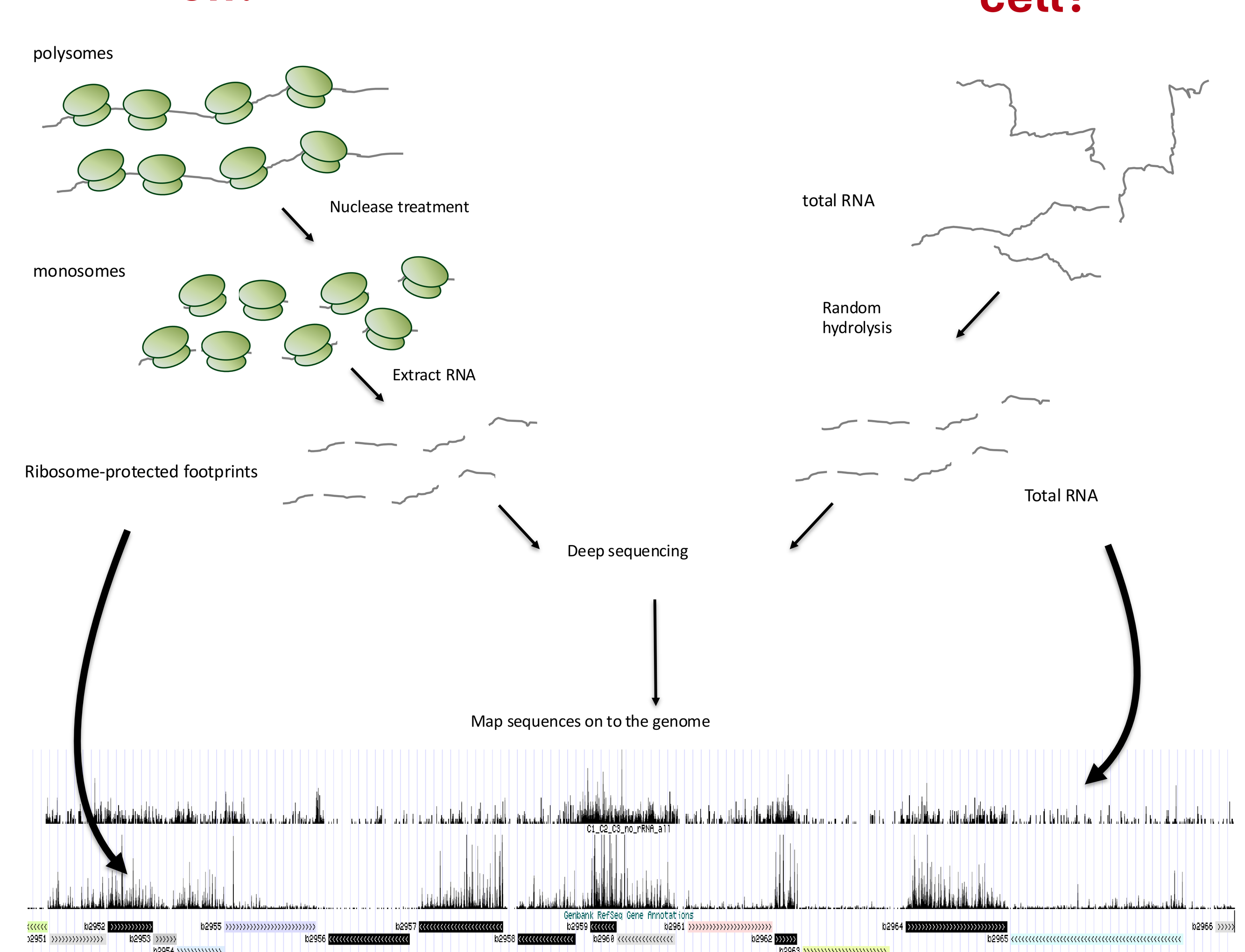
A. fabrum encounters changing environments



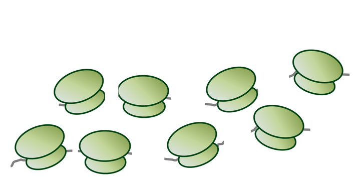
Ribosome profiling

What are the ribosomes sitting on?

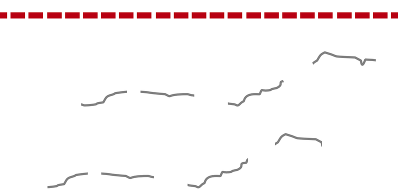
What mRNAs are available in the cell?



Translation Efficiency tells us if the ribosome's behavior changes

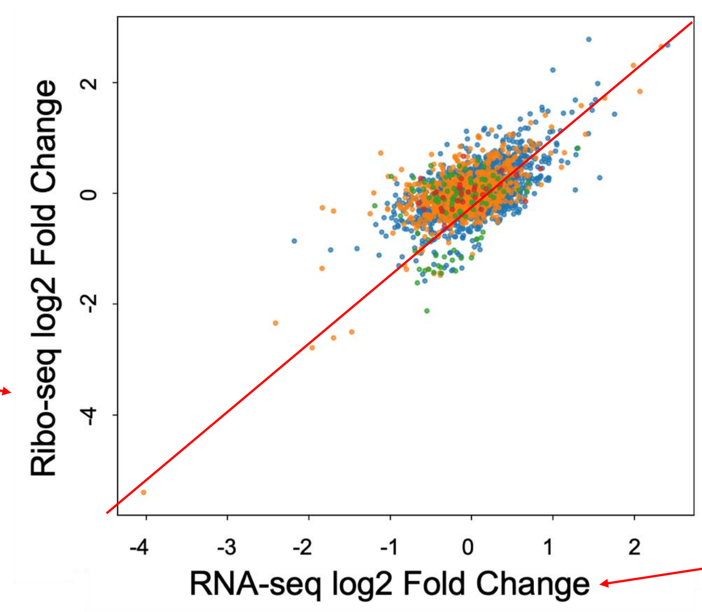


$$\text{Translation Efficiency (for a given gene)} = \frac{\text{ribosome footprints reads (Ribo-Seq)}}{\text{mRNA reads (RNA-seq)}}$$



How to visualize TE?

Each dot = a gene

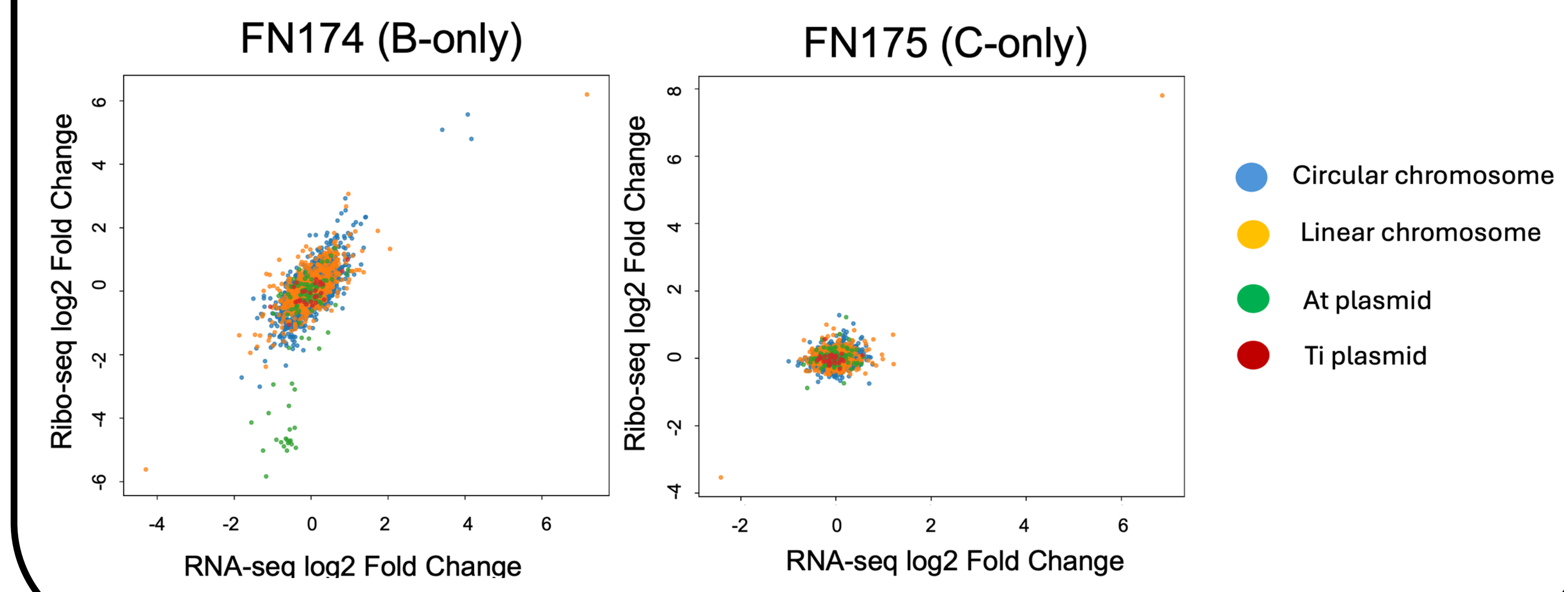


How the ribosome footprints change

Closer to the line = changes in mRNA, not ribosome behavior

How the mRNA changes

bS21-B containing ribosomes behave differently compared to bS21-A and –C containing ribosomes



Summary

- Compositional changes to ribosomes can lead to ribosomopathies, diseases caused by malfunctioning ribosomes
- Changes to the makeup of a ribosome can change how the ribosome behaves
- *A. fabrum* is a plant pathogen that encounters changing environments and may use distinct ribosomes to adapt to those environments
- Ribosome profiling is a method to determine which mRNAs are being actively translated in cells
- Our data suggest that ribosomes containing bS21-B are functionally unique, as they cannot translate certain genes.

References

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