On the importance of bacterial ribosome heterogeneity

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INTRODUCTION

Open questions

What is the functional importance of bL31 paralogs?

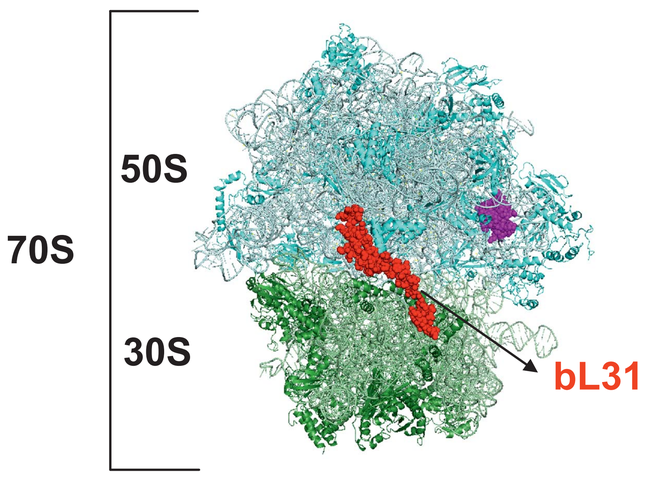
Does ribosome structural heterogeneity confer functional heterogeneity?

Ribosome heterogeneity

- the coexistence of structurally different ribosomes in an organism
- demonstrated at rRNA and r-protein level in prokaryotic and eukaryotic organisms
- at r-protein level: r-protein paralogs, posttranslational modifications, stoichiometric differences

Bacterial ribosome

- 2.3 MDa 2 subunit enzyme (50S, 30S)
- RNA/ protein ratio 2:1
  3 rRNAs + 54 r-proteins in *E. coli*
- highly abundant in fast growing cells:
  appr. 1/3 of cell dry mass and
  70 000 copies per *E. coli* cell



***E. coli* 70S**
Fischer et al, 2015

bL31A paralog	bL31B paralog
both < 10 kDa, sequence ID 35.6%	
duplicated genes in most completely sequenced bacterial genomes	
widely conserved bacteria-specific large subunit protein	
large contact surface with both subunits, forms the B1b intersubunit bridge	
binds one Zn^{2+} ion	does not bind Zn^{2+}
present in *E. coli* exponential phase ribosomes	present in *E. coli* stationary phase ribosomes

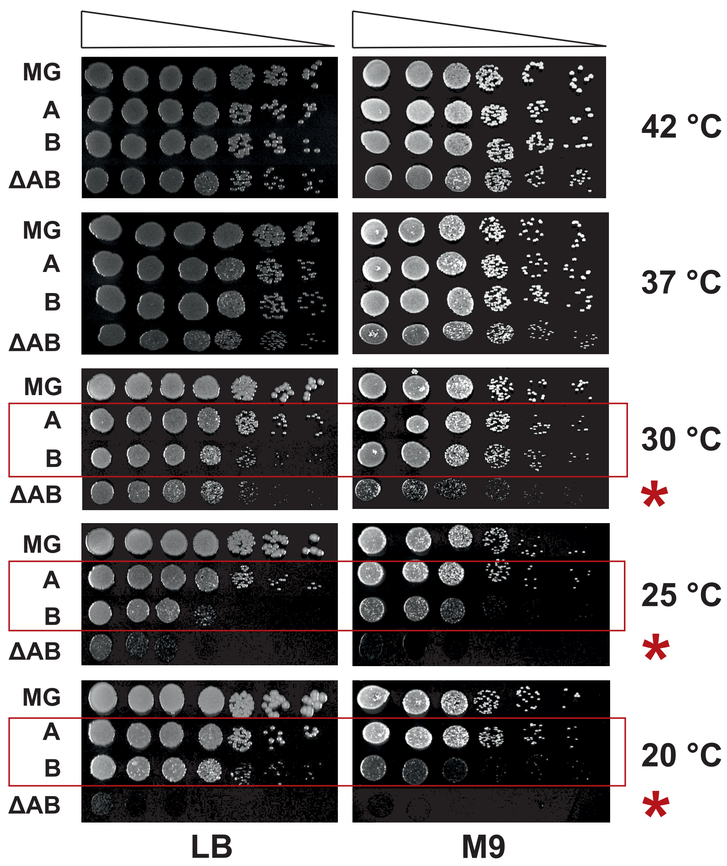
RESULTS

Conclusions

- **Bacterial ribosomes are heterogeneous with respect to bL31 paralogs.**
- **bL31 protein is important for optimal growth at lower temperatures. However, bL31A confers a growth advantage over bL31B.**
- **In growth competition, bL31A gives a fitness advantage under fast growth conditions.**
- **bL31A is important for reading frame maintenanace. The B strain is prone to translational frameshifting.**

bL31A supports growth at lower temperatures and cyclic growth more effectively than bL31B

Growth phenotypes of *E.coli* strains expressing bL31 paralogs

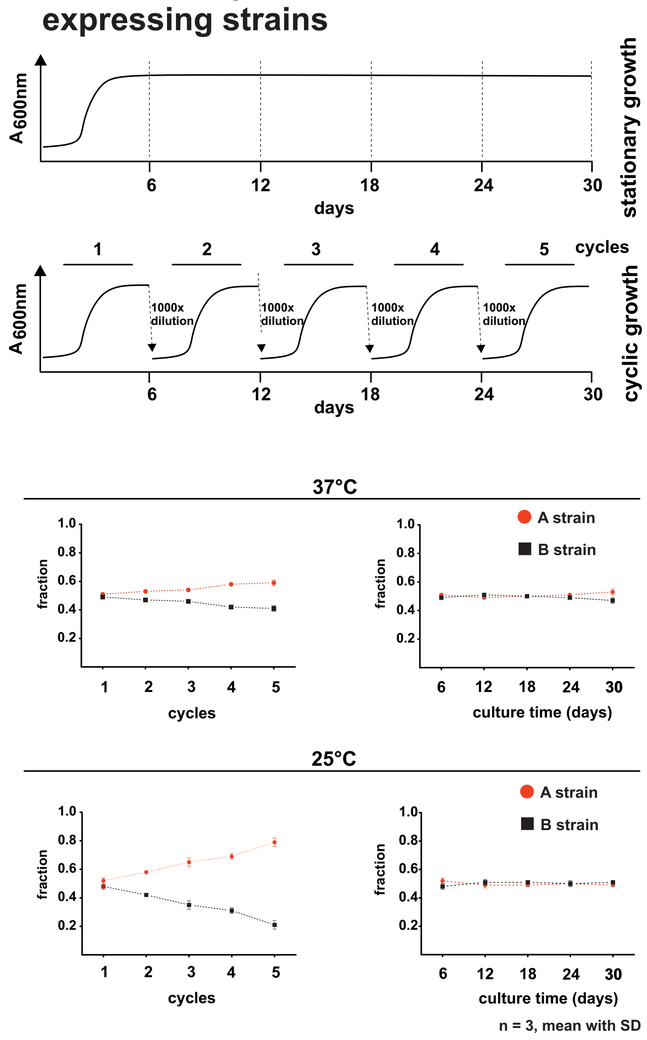


Without bL31 paralogs *E. coli* cells have cold-sensitive growth phenotype.

The strain expressing bL31A paralog has a similar growth to the wild-type strain (MG).

The strain expressing bL31B paralog grows slower than the wild-type strain.

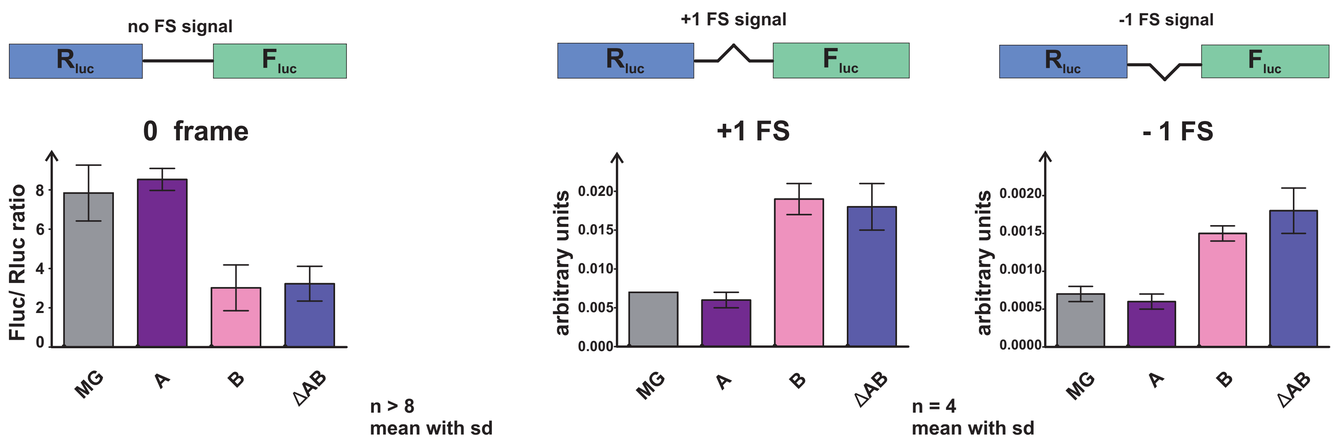
Growth competition of bL31A or bL31B expressing strains



n = 3, mean with SD

bL31A supports bacterial cyclic growth more effectively than bL31B.

bL31 paralogs affect the frequency of translational frameshifting *in vivo*



n > 8
mean with sd

n = 4
mean with sd

According to MS data ribosomes of the wild-type strain contain mostly bL31A protein, of the A-strain only bL31A, of the B-strain only bL31B and of the ΔAB strain neither of the paralogs.

In the B-strain, the Fluc/ Rluc ratio is about 2,6x lower than in the wild-type strain.

In the A-strain, the Fluc/ Rluc ratio is similar to the wild-type strain.

In the B strain, frameshifting frequency is about 2,5x higher than in the wild-type strain.

The A strain displays frameshifting frequency similar to the wild-type strain.

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