Title: Second messenger-sensing riboswitches in bacteria

Author: Arati Ramesh

PII: S1084-9521(15)00216-5
DOI: http://dx.doi.org/doi:10.1016/j.semcdb.2015.10.019
Reference: YSCDB 1849

To appear in: *Seminars in Cell & Developmental Biology*

Second messenger-sensing riboswitches in bacteria

Arati Ramesh[*]
[*]National Center for Biological Sciences, GKVK Campus, Bellary Road, Bangalore, India- 560065
*Corresponding author. Email address arati@ncbs.res.in
Tel: 91-80-2366 6930, Fax: 91 80 23636662

Abstract
Signal sensing in bacteria has traditionally been attributed to protein-based factors. It is however becoming increasingly clear that bacteria also exploit RNAs to serve this role. This review discusses how key developmental processes in bacteria, such as community formation, choice of a sessile versus motile lifestyle, or vegetative growth versus dormant spore formation may be governed by signal sensing RNAs. The signaling molecules that affect these processes, the RNAs that sense these molecules and the underlying molecular basis for specific signal-response are discussed here.

keywords: riboswitch, second messenger, sporulation, biofilms, differentiation

Abbreviations: c-di-GMP, 3’,5’-cyclic-di-guanosine monophosphate; c-di-AMP, 3’,5’-cyclic-di -Adenosine monophosphate; 3’,3’ c-GAMP, 3’,3’ cyclic guanosine monophosphate adenosine monophosphate; 2′,3′-c-GAMP, 2’,3’ cyclic guanosine monophosphate adenosine monophosphate; 5’ UTR, 5’ Untranslated Regions.

1. Introduction: Riboswitches as signal sensors in bacteria

Bacteria sense and respond to their environment. This response occurs not only through protein-based sensors but also via RNAs that directly sense signaling molecules and in turn control gene expression. Such signal sensing RNAs, called riboswitches, typically reside in the 5’ UTRs of mRNA, in a *cis* configuration with respect to the gene that they control. Riboswitches are characterized by an aptamer domain that directly binds a metabolite, and an expression platform that transmits metabolite-induced effects to the downstream gene[1-3] (Figure 1A). Metabolite binding may turn on or off the downstream gene in one of many ways; by modulating a transcriptional terminator to affect genes at the post transcription-initiation level, by modulating the ribosome binding site to control genes at the level of translation initiation, or in rare cases control mRNA stability. More recently it has been shown that a class of riboswitches can coordinate with proteins such as the Rho transcription termination factor to elicit gene regulation[4]. Riboswitches have also been shown to control the expression of other non-coding RNAs[5], suggesting a complex network of RNA-based regulation in bacteria. In eukaryotes, the extent of riboswitch-based regulation is as yet unclear, though a class of thymine pyrophosphate sensing riboswitches has been shown to function via the control of mRNA splicing[6].

Based on the types of metabolites recognized, over 20 families of riboswitches have been identified thus far. Ligands sensed by riboswitches range from complex