Modelling of *patA* and *hetF* gene function in *Anabaena* heterocyst formation

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Differentiated cell types can form patterns in filamentous cyanobacteria. Specifically the genus *Anabaena* has received special interest because under nitrogen-limiting conditions some of the vegetative cells differentiate into a nitrogen-fixing form called heterocyst [1]. These heterocysts cannot undergo cell division or have photosynthetic activity, but share fixed nitrogen products with the whole filament. In order to efficiently distribute the fixed nitrogen, heterocysts are arranged forming quasiregular patterns in the filament.

Recent experimental work [2, 3, 4, 5, 6, 7] has advanced on the understanding of the interactions and genetic mechanisms underlying this pattern-forming process. However, the role of many of the genes involved is still unknown. Two of these genes are *patA*, which has an enigmatic mutant phenotype in which heterocysts are only formed at the extremes of the filament, and *hetF*, whose mutant does not form heterocysts under nitrogen deprivation. In this work we investigate their function and provide a model (Figures 1 and 2), based on previous results [8], that explains how *patA* and *hetF* interact with other genes and affect heterocyst pattern formation and maintenance.

Numerical simulations based on this new model reproduce the phenotypes of all simple and multiple mutant conditions and allow to obtain a more complete knowledge of this paradigmatic example of biological pattern formation.

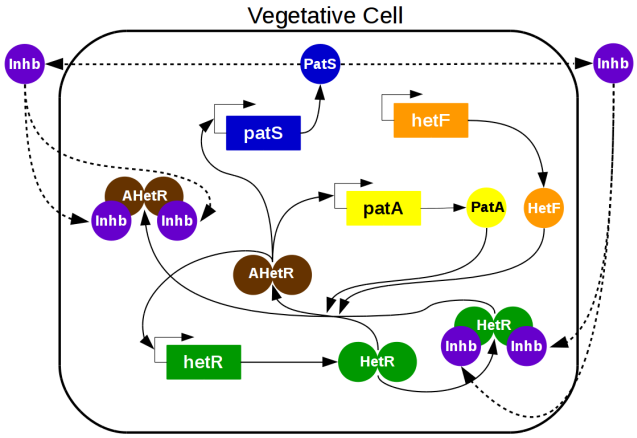

Fig. 1. Vegetative Cell Modelization: While *hetF* (orange) has only a low basal expression, *patA* (yellow) and *patS* (blue) have a regulated expression that depends on the active form AHetR (brown) of the transcription factor HetR (green), which also activates its own expression. At the protein level: The HetR dimer needs to be activated by PatA or HetF to become AHetR. PatS becomes an inhibitor of the transcription factor (purple) by protein transformation during cell to cell transport. The inhibitor thus produced is a small molecule that can diffuse along the filament.

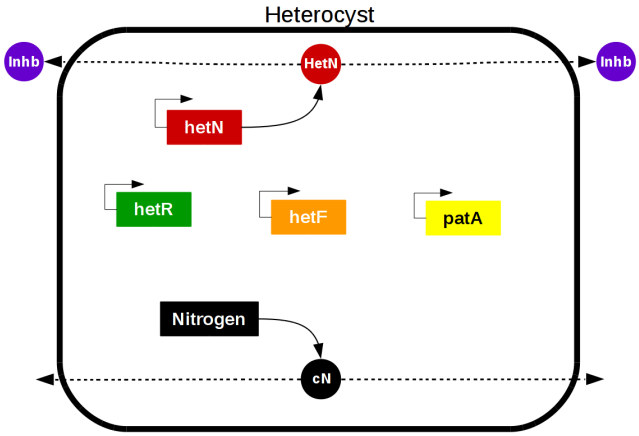

Fig. 2. Heterocyst Cell Modelization: *hetN* (red) is expressed in heterocysts and becomes an inhibitor of the transcription factor (purple), similar at the PatS product, by protein transformation during cell to cell transport. The fixed nitrogen products (black) produced by the heterocyst can also diffuse to act as a inhibitor of AHetR.

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