HfiA Modeling Abstract and Equations

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1 Block-Level Mechanism

1.1 HfiA Background Knowledge

Ref: A Cell Cycle and Nutritional Checkpoint Controlling Bacterial Surface Adhesion

In this paper, author describes a novel regulatory mechanism by which the C.c. bacterium integrates cell cycle and nutritional signals to control development of an adhesive envelop structure known as holdfast.

They discovered a novel inhibitor of holdfast development. HfiA, that is regulated downstream of lovK-lovR. They also discovered a bio-synthesis related gene named HfsJ. And the suppressing mutations in HfsJ attenuate the HfsJ-HfiA interaction.

These results support a model in which HfiA inhibits holdfast development via direct interaction with an enzyme required for holdfast biosynthesis

In conclusion, author says: We demonstrate that the predicted glycosyltransferase, HfsJ, is a required component of the holdfast development machinery and that residues at the C-terminus of HsfJ mediate a direct interation with HfiA, leading to a post-translational inhibition of HfsJ.

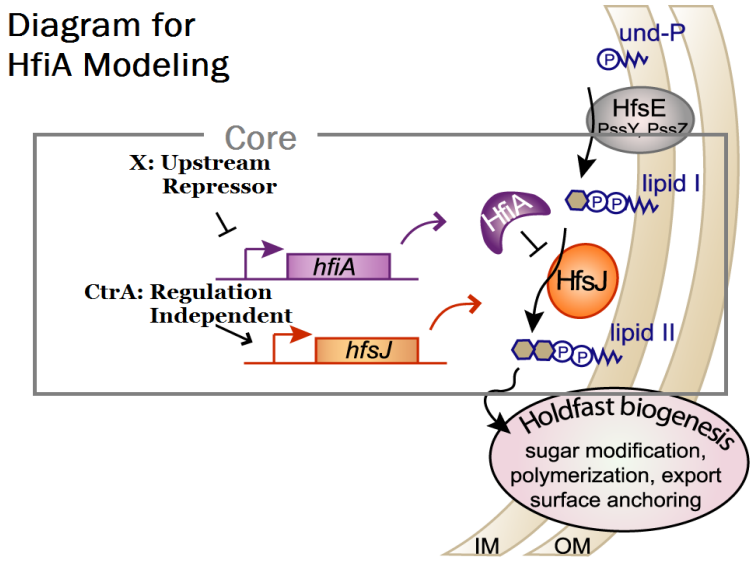
The binding affinity and cellular concentrations of HfiA and HfsJ are tuned such that this regulatory system is responsive to small changes rather than robust to large changes. This prediction is consistent with a highly responsive and sensitive regulatory system.

1.2 HfiA Modeling Abstract

So the block is clear. Upstream promoter Expression Rate → HfiA → HfsJ → Catalysing Rate

2 Equations

2.1 Diagram



2.2 Defination:

1. The maximum transcriptional rate of HfiA gene: β_{HfiA}
2. The transcriptional rate of HfsJ gene: β_{HfsJ}
3. The repressor effect: X
4. The dissociation constant of repressor and HfiA: Kd_{HfiA}
5. The translation rate of HfiA: α_{HfiA}
6. The amount of HfiA protein: P_{HfiA}
7. The degradation rate of HfiA: k_{HfiA}

8. The translation rate of HfsJ: α_{HfsJ}
9. The amount of enzyme HfsJ: Ez_{HfsJ}
10. The amount of complex of HfiA and HfsJ: $C_{HfiA-HfsJ}$
11. The dissociation constant of HfiA-HfsJ: $Kd_{C_{HfiA-HfsJ}}$
12. The degradation rate of HfsJ: k_{HfsJ}
13. The amount of valid enzyme HfsJ: : Ez^*_{HfsJ}

3 Equations:

1. Actual transcriptional rate of HfiA:

$$\beta^*_{HfiA} = \frac{\beta_{HfiA}}{1 + \frac{X}{Kd_{HfiA}}}$$

2. The changing rate of HfiA amount:

$$\frac{dP_{HfiA}}{dt} = \beta_{HfiA}\alpha_{HfiA} - k_{HfiA}P_{HfiA}$$

3. The changing rate of total amount of enzyme HfsJ:

$$\frac{dEz_{HfsJ}}{dt} = \beta_{HfsJ}\alpha_{HfsJ} - k_{HfsJ}Ez_{HfsJ}$$

4. The relationship between valid enzyme amount and total amount:

$$Ez^*_{HfsJ} = Ez_{HsfJ} - C_{HfiA-HfsJ} = Ez_{HfsJ} - Kd_{C_{HfiA-HfsJ}}P_{HfiA}Ez_{HfsJ}$$

5. The output function:

$$Adhesion = f(Ez^*_{HfsJ})$$