Uncovering Small Transmembrane Peptides in Bacteria

Tara Hoffman¹, Jeff Kinne¹, Kyu Hong Cho²
¹Department of Mathematics and Computer Science, Indiana State University
²Department of Biology, Indiana State University

Introduction

In the search to identify genes the main focus has been on genes encoding at least 100 amino acids. Genes for much smaller proteins, i.e., those encoding fewer than 50 amino acids, have been mostly overlooked. Among the potential functions of small proteins, the present study searches for those that are transmembrane. We have implemented a software pipeline that identifies potential small transmembrane peptides by searching an organism’s genome for open reading frames that have a transmembrane signature in their sequence. Since most, if not all, small transmembrane peptides found so far have an alpha helical transmembrane motif, we search for small alpha helical transmembrane peptides. In particular, the side chains of the alpha helix must be hydrophobic, and this characteristic can be searched by existing algorithms. We focus our search on bacteria because bacterial gene structure is simpler (without introns).

Results from S. pyogenes HSC5

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Results from S. pyogenes M1 GAS

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| 186            | NC_000567.1_prot_10224.1_1160 | [location=15399..15414] | Peptic SUM cluster
| 203            | NC_000567.1_prot_10224.1_1160 | [location=15399..15414] | Peptic SUM cluster

Further Directions

• Evaluate other tools for identifying novel genes and compare results with our software pipeline.
• Run our pipeline and analyze results on other bacterial genomes, including those which contain well-documented small transmembrane proteins (to verify our pipeline identifies these known positives).
• Use RNaseq data to confirm that putative small transmembrane protein genes are being transcribed.

References


Acknowledgments

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Figure 1: Functions of known small transmembrane peptides: subunits of a larger protein complexes (such as the CydX, CcoQ and CcoM subunits of a larger protein complexes). (the best characterized examples are the small peptides associated with photosystems I and II as well as cytochrome oxidase, is required for the function of this complex (77-79)). The determinants governing the CytD activity are not fully understood. Conversely, in bacteria (specifically E. coli), they could take on a regulatory role to act as regulators of membrane proteins. In eukaryotes, however, the findings are more diverse, with many genes encoding small transmembrane peptides. The best characterized examples include the small peptides associated with photosystems I and II as well as cytochrome oxidase, which are required for the function of this complex.

Figure 2: The side chains of the alpha helix should be hydrophobic so that it can penetrate through the membrane. One turn of the alpha helix is 5.4 Å. Therefore, in order to penetrate the membrane, it would take 7.4 turns which is 27 Å. An alpha helix. Alpha helices are smaller than beta sheets which is why we look for those rather than beta sheets.