The Characterization of mamJ and mamK in Magnetotactic Bacteria Strain: LEMS

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Abstract

Magnetotactic bacteria are a diverse group of prokaryotes that biomineralize membrane-bounded crystals that process magnetite. The magnetosome is usually aligned within the cell and consists of either magnetite (Fe₃O₄) or greigite (Fe₃S₄). The biomineralization of magnetosomes takes place through multiple processes, including magnetotactic heptaxis; invagination of the cytoplasmic membrane to form vesicles; and further invagination to form the magnetosome membrane vesicle. The outcome of these invaginations is to determine how related mamJ and mamK from a newly isolated and metabolically diverse magnetotactic spirillum: (strain LEMS ) are to other well characterized species of Magnetospirillum. PCR was the primary tool used to determine the sequence of mamJ and mamK of strain LEMS. We used other genomic tools to determine the similarity and related of these genes with those of other Magnetospirillum species. The information gained from the successful sequencing of these genes form strain LEMS will provide valuable information in determining whether strain LEMS contains a magnetosome gene island and what the order of these genes are within the island.

Methods

The 16s RNA, mamJ and mamK genes were amplified using specific primers for these genes based on conserved sequences in various databases and published phylogenetic trees (Howse et al. 2013). The amplified mamJ and mamK genes were cloned into the vector pGEM-T Easy (Promega) and sequenced using T7 and SP6 primers for both orientations. The sequences for the MamJ and MamK genes were aligned in Clustal Omega and phylogenetic trees were created using the neighbor-joining method.

Data/ Results Cont.

Figure 1A: Diagram showing the function of MamJ and MamK in the biomineralization and alignment of magnetosomes in Magnetospirillum species. MamK forms the long magnetosome filaments that position magnetosome vesicles in chains while MamJ connects the magnetosome vesicles to MamK.

Figure 1B: Illustration of the magnetosome island (MAI) in Magnetospirillum gryphiswaldense strain MSR-1.

Introduction

Magnetotactic bacteria (MTB) are a highly diverse group of prokaryotes that contain membrane-bounded magnetic crystals. Magnetosomes can be used to create a variety of products, including magnetic separation, magnetic storage, and magnetic respondents. The magnetosome genes in every magnetotactic bacteria genome examined showed a high degree of conservation, and this conservation is likely due to the essential function of the magnetosomes in the cell. The presence of these genes in the genome of magnetotactic bacteria suggests that these organisms are capable of biomineralization.

Results

Phylogenetic trees were constructed with neighbor joining, and bootstrap inferred phylogeny using the Mega4 program.

Conclusion/Future Research

In general, phylogeny based on the MamK gene in MTB did support the associations of organisms as shown in the 16s rRNA gene. That is, the Magnetospirillum species clustered together with the unclassified strain MV-1, MS-1, and RS-1. Further studies are needed to determine the function of these genes in these organisms.

Acknowledgements

I thank my research mentor, Dr. Dennis A. Bazylinski for his support and encouragement. I thank Paul Howse for analyzing the data for the 16s rRNA gene. I thank the National Science Foundation REU Program at UNLV (REU 0649267) for funding this research.

References


Figure 2: Phylogenetic tree of selected magnetotactic bacteria based on sequence of the 16s rRNA gene. All organisms belong to the alpha-subgroup of the Proteobacteria except Desulfovibrio magneticus strain RS-1 which is a member of the delta-subgroup of the Proteobacteria. The tree represents a mostly isolated strain of Magnetospirillum gryphiswaldense strain MSR-1. The newly determined species isolated from Lake Millerton, Lake Mead, and LEMS are shown on the right side of the tree. The branches represent the evolutionary relationships among the organisms as determined by the 16s rRNA gene sequence.

Figure 3: Phylogenetic tree of several Magnetospirillum of which all possess mamK. Strain designations are the same as in Figure 2. Strains MC-1 and MV-1 are not Magnetospirillum species.

Figure 4: Phylogenetic tree of several Magnetospirillum species of which all possess mamJ. Strain designations are the same as in Figure 2. Strains MC-1 and MV-1 do not contain mamJ and thus were not included.