**Diversity of Cell Envelops in the Archaea.**

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Archaea possess a distinct cell envelope type comprised of a protein lattice called an surface layer or S-layer surrounding the cell membrane in contrast to the peptidoglycan-containing envelopes of the gram positive and gram negative bacteria. The archaeal S-layers are typically assembled from one or two abundant and often post-translationally modified proteins that are exported from the cell and then assembled into a highly organized surface-exposed lattice. This envelope protects the cell membrane from environmental damage while also allowing movement of essential nutrients into the cell. Little is known about the identities or properties of the surface layer proteins in archaeal species.

To experimentally address the above questions regarding the envelope proteins in several model archaeal species, we devised methods to isolate their S-layers and to identify the major polypeptide components using mass spectrometry methods. We also verified the surface exposure of these proteins using cell labeling methods by *in vivo* biotinylation methods that affinity tag surface-exposed molecules. Of the environmentally representative species within the family *Methanosarcinaceae*, the major S-layer proteins were identified for *Methanosaricna mazei* Gö1, *Methanosarcina acetivorans* C2A, and *Methanosarcina barkeri* fusaro. Previously annotated as hypothetical proteins in each species, all were subsequently shown to exist in multiple glycosylated forms by using SDS-PAGE coupled with glycoprotein-specific staining, and by interaction with the lectin, Concanavalin A. To address the structure of these S-layers, crystallographic studies were also performed with the model S-layer protein from *M. acetivorans* C2A. The 2.5 Angstrom resolution structure obtained reveals the first high resolution view of an archaeal cell surface lattice. The structural model also reveals how the S-layers are anchored to the cell membrane and how they allow movement of small molecules into and out of the cell. Related envelope studies with other model archaeal species will be compared and contrasted to the above *Methanosarcinaceae* studies to highlight the diversity of archaeal envelope types.