Electronic Conductivity in Supramolecular Biomaterials

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Electronic transport is conventionally the domain of man-made materials and devices, but anaerobic respiration by some sediment microbes requires shuttling electrons from the cell to remote electron acceptors. Research over the past decade established that these microbes have also adapted protein supramolecular assemblies that exhibit inherent conductivity. Based on fundamental differences between the protein building blocks of these assemblies and the canonical building blocks of inorganic and organic conductors and semiconductors, it is clear that Nature has developed unique design principles for long-range electronic conducting systems. The biomolecular identity and supramolecular order underpinning biological conductive materials are poorly understood, as are the mechanisms by which these structures support electron transport. In this talk, I will discuss my group's ongoing work in the characterization of charge transport mechanisms in protein nanowires. These efforts establish distinctive biomolecular design principles for long-range electron transport in self-assembling peptide nanofibers and native bacterial appendages. Such materials serve as an experimental platform to understand long-range charge transport in biological materials in general, and as promising technological platforms for bioelectronic interfaces.