Highly conductive fibres enable centimetre-scale electron transport in multicellular cable bacteria

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Electron transport in biological systems is classically thought to occur over nanometre to micrometre distances. Yet, recent studies on filamentous cable bacteria suggest that electrical currents can also run along centimetre-long multicellular filaments. So far, this phenomenon of long-distance charge transfer has remained highly elusive, as currents have not been directly measured, nor have the underlying conductive structures been identified. Here, we demonstrate that cable bacteria internally conduct electrons over centimetre-scale distances via a network of highly conductive fibres embedded in the cell envelope. Direct measurements on intact bacterial filaments placed between electrodes reveal nanoampere currents at 100 mV bias. Conduction was demonstrated in filaments up to 10.1 mm long (>2000 adjacent cells), thus increasing the known range of biological charge transport by orders of magnitude.

We furthermore isolated a regular network of parallel fibres from the periplasm, which displayed a high conductivity (up to 79 S cm^{-1}), sufficient to explain the currents measured through intact filaments. Conductance rapidly declines upon exposure to air, but remains stable under vacuum conditions, demonstrating that charge transfer is electronic rather than ionic. Our findings reveal a novel biological structure with an unprecedented conductivity that greatly expands the paradigm of biological charge transport and could enable new bio-electronic applications.