

The ubiquity of adenosine triphosphate (ATP) as the universal energy currency across almost all species underscores its pivotal role in facilitating life. Psychrophiles, cold loving organisms, face formidable challenges in ATP synthesis, given the temperature-dependent decrease of enzymatic rate, a phenomenon known as the Arrhenius relationship. *Mesenchytraeus solifugus*, is such a psychrophile which potentially utilizes a distinct strategy in overcoming this obstacle via a C-terminal extension of the mitochondrially encoded ATP6 subunit of the ATP synthase complex. To investigate the efficacy of this adaptation, we engineered a fusion of this extension and the homologous protein AtpB in *E. coli* (dubbed exAtpB), revealing a significant increase in the maximum velocity (V_{max}) of the ATP synthase complex. Remarkably, this enhancement persisted across other bacterial species such as *Caulobacter crescentus* despite minor component and structural differences in the ATP synthase complex. The broad efficacy of this C-terminal tail across species underscores its potential as a simple yet potent modulator of ATP synthase catalytic efficiency.