Aging, entropy and waste: Flushing out damaged cells

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One theory of aging invokes the Second Law of Thermodynamics and suggests that in the long-term, the heat energy generated by metabolic changes causes damage to living systems that accumulates as repair mechanisms cannot keep pace with the damage, entropy accumulates, and this is manifest in the signs of aging that are all too familiar—graying hair, wrinkled skin, immune compromise, organ failure, cognitive decline.

A team from Turkey, writing in the *International Journal of Exergy*, point out that as is ever the case with living systems, the picture is far more complicated. Indeed, an individual is not truly a single living thing given the presence of myriad microbes that live on the skin and within the alimentary canal, for instance. Indeed, the team from Yeditepe University in Istanbul explain that the human gut microbiota acts as an autonomous thermodynamic subsystem within what we ought to refer to as the human superorganism. These microbes generate and export their own entropy without causing age damage to their human host.

The team's thermodynamic calculations show that between 12 and 59 percent of the metabolic entropy generated by each of us as a whole is produced by the microbial guests in our gut and exported in feces. This entropy is not associated with aging damage.

The researchers explain how entropy removal via the waste stream from a chemical plant is well known and discussed at length in the pertinent scientific literature. Given that we know from the work of Schrödinger

and Prigogine that living systems must import energy and export entropy to maintain their living state this new research into the entropy export by the gut microbiota could open up new avenues for research into aging that have not previously been considered in depth.

More information: Cennet Yıldız et al. Fraction of the metabolic ageing entropy damage to a host may be flushed out by gut microbiata, *International Journal of Exergy* (2021). DOI: 10.1504/IJEX.2021.113004

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