Energetic evolution of cellular Transportomes - DTU Orbit (17/08/2019)

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Background: Transporter proteins mediate the translocation of substances across the membranes of living cells. Many transport processes are energetically expensive and the cells use 20 to 60% of their energy to power the transportomes. We hypothesized that there may be an evolutionary selection pressure for lower energy transporters.

Results: We performed a genome-wide analysis of the compositional reshaping of the transportomes across the kingdoms of bacteria, archaea, and eukarya. We found that the share of ABC transporters is much higher in bacteria and archaea (ca. 27% of the transportome) than in primitive eukaryotes (13%), algae and plants (10%) and in fungi and animals (5–6%). This decrease is compensated by an increased occurrence of secondary transporters and ion channels. The share of ion channels is particularly high in animals (ca. 30% of the transportome) and algae and plants with (ca. 13%), when compared to bacteria and archaea with only 6–7%. Therefore, our results show a move to a preference for the low-energy-demanding transporters (ion channels and carriers) over the more energy-costly transporter classes (ATP-dependent families, and ABCs in particular) as part of the transition from prokaryotes to eukaryotes. The transportome analysis also indicated seven bacterial species, including Neorickettsia risticii and Neorickettsia sennetsu, as likely origins of the mitochondrion in eukaryotes, based on the phylogenetically restricted presence therein of clear homologues of modern mitochondrial solute carriers.

Conclusions: The results indicate that the transportomes of eukaryotes evolved strongly towards a higher energetic efficiency, as ATP-dependent transporters diminished and secondary transporters and ion channels proliferated. These changes have likely been important in the development of tissues performing energetically costly cellular functions.