PROTEIN FOLDING

Dual chaperone function

> cytosolic and nuclear functions [of chaperones] in protein folding and ribosome biogenesis

Chaperones support protein folding in different cellular compartments and some chaperones associate with ribosomes to help fold newly synthesized proteins. Two studies by Koplin *et al.* and Albanèse *et al.* now reveal that, in addition to promoting protein folding, the yeast chaperone system RAC–SSB (ribosome-associated complex–stress 70B; in which RAC acts as a co-chaperone for the functionally interchangeable SSB proteins Ssb1 and Ssb2), the nascent chain-associated complex (NAC) and the chaperone Jjj1 (which is a co-chaperone for the Hsp70 chaperone SSA) also help with assembling ribosomes.

Genetic interaction studies showed that RAC, which consists of zuotin (Zuo1) and Ssz1, and the Zuo-like protein Jjj1, have distinct but overlapping biological functions. The same was found for NAC and the RAC–SSB system. Interestingly, Albanèse *et al.* and Koplin *et al.* found that combined deletion of the *JJJ1* gene and the *SSB1* and *SSB2* genes caused synthetic lethality, which implies that RAC–SSB and Jji1 function in distinct pathways.

Cells lacking both SSB and NAC accumulated aggregates consisting mostly of ribosomal proteins and pre-ribosomal RNA (rRNA) species. Furthermore, double-deletion strains for RAC–SSB and NAC and for RAC and Jjj1 showed a reduction in the levels of 80S ribosomes and translating polysomes as well as the 60S and 40S subunits. Albanèse *et al.* further showed that the loss of Zuo1 and Jjj1 led to the accumulation of immature 27S rRNA precursors, a hallmark of defective 60S ribosomal subunit maturation. Microarray analysis allowed the detection of deficiencies in 27S and 35S rRNA processing in strains with Jji1 or RAC deletions, although the processing defects were not identical, confirming that their functions are only partially overlapping. Using a green fluorescent protein-labelled ribosomal protein, both groups further showed defects in the export of 60S subunits from the nucleus to the cytoplasm, and recycling of the shuttling factor Arx1 back to the nucleus was impaired.

Together, these data indicate dual cytosolic and nuclear functions for RAC–SSB, NAC and Jji1 in protein folding and ribosome biogenesis, respectively. However, how these dual roles are coordinated and how these chaperones promote ribosome biogenesis remains unclear and will be important research directions for the future.

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SUPERSTOCK

ORIGINAL RESEARCH PAPERS Koplin, A. *et al.* A dual function for chaperones SSB–RAC and the NAC nascent chain polypeptide-associated complex on ribosomes. *J. Cell Biol.* **189**, 57–68 (2010) | Albanèse, V. *et al.* A ribosome-anchored chaperone network that facilitates eukaryotic ribosome biogenesis. *J. Cell Biol.* **189**, 69–81 (2010)
FURTHER READING Karbstein, K. Chaperoning ribosome assembly. *J. Cell Biol.* **189**, 11–12 (2010)