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Physiological Functions of Polyamines and Regulation of Polyamine Content in Cells

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Polyamines (putrescine, spermidine and spermine) are necessary for cell growth. We studied regulation of polyamine content in cells and the physiological functions of polyamines. It was found that antizyme, a regulator of polyamine content, not only caused the degradation of ornithine decarboxylase, an enzyme to synthesize putrescine, but also inhibits polyamine uptake. It was also shown that polyamines are necessary for cell growth by generating knock-out mice of *S*-adenosylmethionine decarboxylase, an enzyme to synthesize spermidine and spermine. Furthermore, we characterized four polyamine transport systems in *E. coli* and nine polyamine transport systems in yeast.

As for the physiological functions of polyamines, we have proposed an idea to explain how polyamines enhance cell growth in *E. coli*. We found that synthesis of oligopeptide binding protein (OppA), which is important for nutrient supply, adenylate cyclase (Cya), RNA polymerase σ^{38} subunit (RpoS), transcription factor of iron transport operon (FecI), and transcription factor of growth related genes including rRNA and some kinds of tRNA synthesis (Fis) was enhanced by polyamines at the level of translation. We proposed that a group of genes whose expression is enhanced by polyamines at the level of translation be referred to as a "polyamine modulon". By DNA microarray, we found that 309 of 2,742 mRNA species were up-regulated by polyamines. Among the 309 up-regulated genes, transcriptional enhancement of at least 58 genes might be attributable to increased levels of the transcription factors Cya, RpoS, FecI, and Fis. This unifying molecular mechanism is proposed to underlie the physiological role of polyamines in controlling the growth of *E. coli*.