

URLs

GENE EXPRESSION

## Which mean do you mean?

There is considerable variation in gene-expression levels between individual cells. Bengtsson *et al.* show that these levels are distributed log-normally rather than normally, which implies that the arithmetic mean does not represent the situation in a typical cell. They also show that the levels of expression of different genes in the same cell do not generally correlate, and suggest that mechanistic conclusions can be drawn when they do.

Using reverse transcriptase quantitative real-time PCR, they measured the transcript levels of 5 genes in 169 mouse pancreatic cells. For each gene the results were distributed log-normally across the sample cells, making the geometric mean a more appropriate representation of the data than the more commonly quoted arithmetic mean. For the insulin genes, *Ins1* and *Ins2*, up to 9-fold differences were found between the arithmetic and geometric means.

Of the five genes studied, only *Ins1* and *Ins2* expression levels correlated at the level of the individual cell. Levels of *ActB*, the  $\beta$ -actin gene, correlated with these two only at the overall population level, whereas levels of the final two genes did not correlate with any of the others. This indicates that expression-level differences in individual genes are not due to cells having different levels of overall transcription. The authors suggest that genes that correlate at the individual cell level are coordinately regulated, whereas those

that correlate at the population level merely respond to the same environmental stimuli.

The importance of these findings is demonstrated by the fact that we might have underestimated the effect of glucose on insulin expression by almost 4-fold, which could be important in the administration of therapeutic insulin.

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### References and links

ORIGINAL RESEARCH PAPER

Bengtsson, M. *et al.* Gene-expression profiling in single cells from the pancreatic islets of Langerhans reveals lognormal distribution of mRNA levels. *Genome Res.* **15**, 1388–1392 (2005)

