Researchers find universality in protein locality

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A team of researchers has mapped out a universal dynamic that explains the production and distribution of proteins in a cell, a process that varies in detail from protein to protein and cell to cell, but that always results in the same statistical pattern. The findings, which appear in the journal *Physical Review E*, potentially offer new insights into explaining the variability in phenotypes, or physical appearances.

"An interesting consequence of our findings is that phenotypic variability reflects in a fundamental way the dynamical processes going on in the cell," explains study co-author Daniel Stein, a professor in NYU's Department of Physics and Courant Institute of Mathematical Sciences.

The study's other researchers included: Naama Brenner of Israel's Technion; Charles Newman, a professor at NYU's Courant Institute of Mathematical Sciences; Dino Osmanovi? and Yitzhak Rabin of Israel's Bar-Ilan University; and Hanna Salman of the University of Pittsburgh.

For years, scientists' analyses of protein distributions revealed that the number of copies of any single protein fluctuates strongly from cell to cell—and even in a single cell line between one division and the next. This is true even for proteins that are essential to the cell's survival, where one might initially expect the copy number to be tightly controlled.

More recently, however, studies on single-celled organisms, such as yeast or bacteria, have found a "rhyme" to protein activity—specifically, they all are distributed in the same way: on a single, skewed curve. Not understood, however, has been the reason behind this behavior.

To address this question, the scientists constructed a theoretical model that could be mathematically solved and explored the implications of its results. Their results showed that three very general processes determined protein distribution: growth, division, and feedback.

While growth and division had already been explored by others, the results from the model indicated that a new process - feedback - was necessary. Without this regulatory force, the scientists concluded, there is no mechanism to stabilize protein production. With it, all experimentally observed data can be explained and predictions for future experiments can be made.

"The total content of highly expressed proteins is under the control of what is clearly an overarching cellular feedback mechanism, which indicates a universality to the production of proteins," observes Stein.

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