The molecular architecture of cell fission processes has been revealed

July 15 2015

From left to right, Vadim Frolov, Eva Rodríguez and Anna Shyrova. Credit: Laura López, UPV/EHU

Biological evolution has always gone hand in hand with cell evolution. The cells of eukaryotes, the most advanced branch in the evolutionary tree, are characterised by the fact that their nuclei are separated by a membrane. This membrane is in fact a dynamic labyrinth of interconnected compartments, and each one has a specific function.

These compartments communicate with each other by means of specialised connectors and carriers. One example of these carriers is the transport vesicles that allow cell material to pass between the different compartments. The biogenesis of vesicular transport indicates the highest level of cell development, and in turn, the appearance of protein systems controlling this transport coincides with the appearance of the central nervous system.

A clear example of the link between biological and cell evolution are the proteins of the dynamin superfamily, because their evolution goes hand in hand with the evolution of cell organelles. Specifically, dynamins are involved in the remodelling (splitting and fusion) of the membrane into different cell compartments. The founder member of this family is dynamin 1, which operates in the neurons and controls the remodelling of the membranes during the transmission of nerve impulses between brain cells. This protein has been the subject of a recent study developed in the Membrane Nanomechanics group of the UPV/EHU's Biophysics Unit in collaboration with leading research groups in the United States and Germany. The results of the study have been published recently in the prestigious journal *Nature*.

Dynamin 1 acts on nanometric scales by dividing the membranes in mere fractions of seconds. What has been achieved for the first time in this piece of research is the studying of the transformations caused by this protein on the membrane when it splits using protein engineering.

The researchers "froze" the conformations of dynamin 1 in its various phases, which enabled them to correlate the transformations of the membrane with the dispositions adopted by the protein during its action. To do this, they developed new membrane nanomodels, which meant that the processes could be analysed in individual models.

What is new about the study is that the existence of a specific sequence of intermediate structures of the membrane when it splits has been experimentally proven for the first time. This sequence had only previously been proposed by theoretical studies. What is more, taking a simulation study as the basis, the authors propose that these intermediate structures are a common feature in all the fusion and fission processes of the membrane in cells.

The results of the study will make it possible to analyse how the proteins evolved to control the cell membranes, and will also expand our knowledge about the basic mechanisms of vital cell processes (for example, endocytosis, by which the cell takes in large molecules or particles) and pathogenic ones (such as viral infections).

More information: Juha-Pekka Mattila, Anna V. Shnyrova, Anna C. Sundborger, Eva Rodriguez Hortelano, Marc Fuhrmans, Sylvia Neumann, Marcus Müller, Jenny E. Hinshaw, Sandra L. Schmid & Vadim A. Frolov. A hemi-fission intermediate links two mechanistically distinct stages of membrane fission. *Nature* (2015) DOI: 10.1038/nature14509

Provided by University of the Basque Country