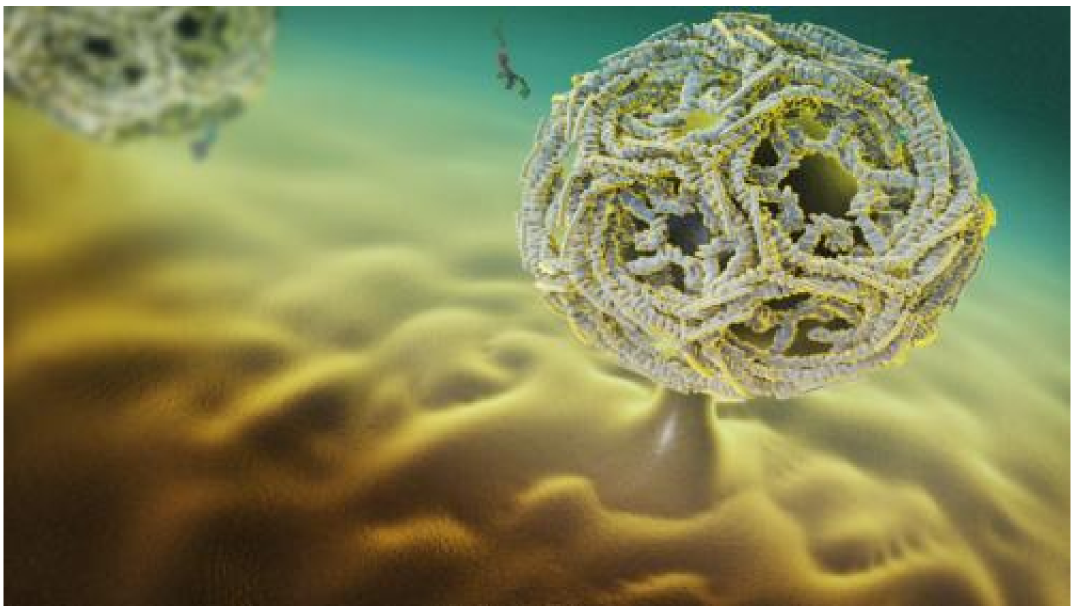
New measures call theories about endocytosis into question

February 19 2015



Protein of clathrine, with its caracteristic form. Credit: University of Geneva

Cellular biology still harbors mysteries. Notably, there is no unequivocal explanation behind endocytosis, the biological process that allows exchanges between a cell and its environment. Two hypotheses prevail for explaining how the wall caves in and forms transport vesicles: either the initial impetus is due to a scaffold-like structure which the soccer ball-shaped clathrin proteins build between themselves, or clathrin's role is minor, and it is other, &laquoadaptor" proteins who exert pressure on the cell wall until endocytosis begins. One recently completed study by the Faculty of Science at the University of Geneva (UNIGE) reconciles the two theories, suggesting a balance between forces present: clathrin proteins are only slightly more influential than the others, and it is a clever combination of physical mechanisms that contributes to creating favorable conditions for the deformation of the membrane. These conclusions captured the interest of the editors of *Nature Communications*, who just published them.

In vitro procedures by researchers in UNIGE's Department of Biochemistry shed new light on the phenomenon of endocytosis, the biological cycle that takes place at the membrane level, and ends with the formation of the transport compartments necessary for external exchanges.

During endocytosis, the cell membrane of eukaryotic organisms becomes deformed, puckering and caving in, creating vesicles for transporting elements - like ions, nutrients, and signals - that are necessary for life. This compartment is deployed from the membrane towards the inside of the cell; its creation implies the use of a lot of energy, and a significant physical force. Two hypotheses provide different explanations for its origins.

A suction cup shaped like a soccer ball, or strong &laquoadaptors" that act as wedges?

In order to explain the genesis of the phenomenon, the scientific community that specializes in the study of endocytosis offers two dominant theories: the first, in which clathrins, proteins shaped like soccer balls that build lego-like structures with each other, act as a suction cup that can suck in the cellular membrane and make it curved. The other theory gives the predominant role to other &laquoadaptor" proteins, which work with clathrins, and deform the membrane in the same way that a wedge is used to split wood.

In Aurélien Roux's laboratory, Saleem Mohammed's delicate processes turn these perspectives upside down by reconciling the two hypotheses: it is not that the energy deployed by clathrin proteins to build scaffold-like structures between each other exceeds what is needed to deform the membrane. Nor that the adaptors broach the membrane by themselves.

Forces balance to open the membrane

Although clathrin remains the main agent behind endocytosis, it doesn't act as a steamroller. Its influence is more subtle than the suction cup hypothesis posits. This assembly protein's energy will join that of the adaptors, which are binding proteins, to make the cellular membrane curve inwards. The membrane has several special characteristics of its own, making it an endlessly fascinating field of research. Its plasticity and elasticity resemble that of human skin, while it has the kind of fluidity and malleability of a soap bubble. Impermeable and self-healing, the cellular membrane guarantees the integrity of the eukaryotic cell.

Physics could therefore be a great help when studying the biology of such a complex ensemble of lipids, sugars, and proteins. This is the multi-disciplinary approach favored by Aurélien Roux, who states that &laquoCellular biology is undergoing a revolution in terms of methodology: the quantitative aspect plays a significant role, and mathematics and physics help bring about new models for understanding the subtleties of life."

Provided by University of Geneva

Citation: New measures call theories about endocytosis into question (2015, February 19) retrieved 26 April 2024 from https://phys.org/news/2015-02-theories-endocytosis.html