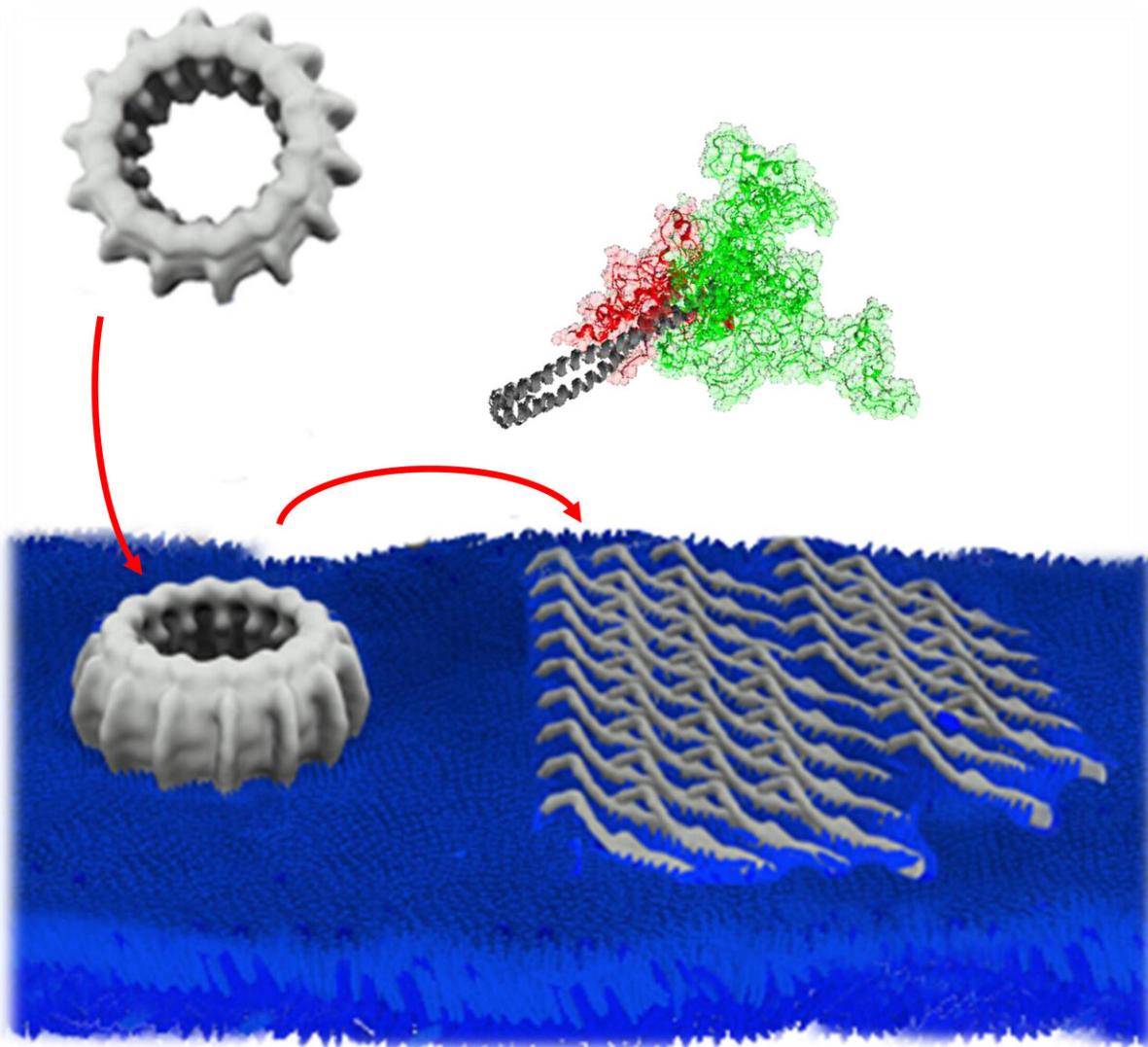


Protective shield: Membrane-attached protein protects bacteria and chloroplasts from stress

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Multiple IM30 proteins form large, oligomeric ring structures. IM30 rings bind to stressed membrane surfaces, disassemble, and individual proteins partially unfold. Multiple IM30 proteins form a protective carpet structure on the membrane surface. Credit: Dirk Schneider and Benedikt Junglas, JGU

Bacteria and plant cells have adapted to cope with stress. They express specific stress proteins, but how this line of defense works is still unclear. A group of scientists headed by Professor Dirk Schneider of Johannes Gutenberg University Mainz (JGU) has now discovered a protective mechanism in cyanobacteria as well as in chloroplasts of plant cells: Complex ring structures formed by a protein attach to cell membranes and dissociate. Thereafter, the individual proteins spread out on the membrane surface and form a carpet structure. "Via formation of such a shield, bacteria and chloroplasts protect their membranes under certain stress conditions," says Professor Dirk Schneider, head of the Membrane Biochemistry section at the JGU Department of Chemistry.

The biochemist and his team have examined the protein IM30, the [inner membrane](#)-associated protein, which has a mass of approximately 30 kilodaltons. Previous studies have already shown that the IM30 protein is involved in the formation and preservation of membranes in photosynthetic cells. Without IM30, the amount of thylakoid membranes, in which the photosynthetic light reaction occurs, decreases, ultimately resulting in cell death. The hitherto unknown molecular mechanism of membrane stabilization has now been observed and revealed in detail. The results of this collaborative research project have recently been published in *Communications Biology*.

Atomic Force Microscopy (AFM) reveals ring disassembly and carpet formation

"For quite some time now, we were well aware that IM30 is somehow related to stress. However, we did not know how exactly these proteins manage to protect the cells on a molecular level," explains Schneider. Employing biochemical and biophysical methods in cooperation with Professor Stefan Weber of the Max Planck Institute of Polymer Research in Mainz and Professor Eva Wolf of the Institute of Molecular Biology (IMB), the mystery was finally solved. Using [atomic force microscopy](#), the scientists were able to observe how the ring structures disassemble and form carpets on membrane surfaces. "For the very first time we were able to visualize the neat IM30 [structure](#) on the surface of membranes," said Schneider.

Intrinsically disordered proteins have important functions

IM30 belongs to the group of intrinsically disordered proteins, which have shifted into the focus of science in recent years. When IM30 binds to the membrane, it unfolds in half, which makes it particularly complicated to study. The traditional understanding of proteins has been based on the assumption that their function is associated with its structure and that disordered structures more or less take over no function. "It is now becoming increasingly clear that disordered protein regions can be involved in defined interactions," says Schneider with regard to the classification of the results in a large-scale context.

The study defines the thus far enigmatic structural basis for the physiological function of IM30 and related proteins, including the phage shock protein A (PspA), the main representative of the protein family to which IM30 belongs. It also "highlights a hitherto unrecognized concept of membrane stabilization by intrinsically disordered proteins," the authors write in the *Communications Biology* paper. In fact, self-organization of proteins on membrane surfaces, resulting in membrane-

covering protein structures, has been observed previously in Alzheimer's and Parkinson's. In these cases, however, the result is membrane destabilization. In contrast, the protective protein carpet formed by IM30 results in membrane stabilization.

"Our discovery now answers the longstanding question as to how, exactly, the protein protects the membrane. This, however, raises new questions, for example, exactly how the individual proteins interact on the membrane surface and form the carpet," said Schneider about the research now planned.

More information: Benedikt Junglas et al, IM30 IDPs form a membrane-protective carpet upon super-complex disassembly, *Communications Biology* (2020). [DOI: 10.1038/s42003-020-01314-4](https://doi.org/10.1038/s42003-020-01314-4)

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