Contribution ID: **29** Type: **Poster**

Discovery of the complex behavior of biological membrane domains in cells and model membrane systems.

Biological membranes are known for their complexity, with the formation of membrane domains, such as membrane rafts, being of central importance for the successful execution of various cellular processes. However, due to their nanoscale properties, these domains are often understudied as the experimental techniques required for their quantitative investigation are challenging. To address this issue, we have utilized both super resolution imaging and advanced biophysical approaches such as fluorescence lifetime imaging microscopy (FLIM) and spot-variation fluorescence correlation spectroscopy (svFCS) to study rafts in cell membranes and model membrane systems. We demonstrated that some peripheral proteins act as key raft-capturing molecules that regulate the temporal immobilization of membrane nanoclusters and control the local concentration and confinement of membrane raft makers. We also developed an original methodological approach combining confocal microscopy, svFCS and Z-scan approach together with giant unilamellar vesicles (GUVs) to obtain quantitative data on the behavior of signaling lipids in free-standing membranes. Not only did we succeed in comprehensively describing the dynamics and domain formation of these lipids at the nano- and microscale, but also in demonstrating that minute differences in their structure strongly influence the behavior of these lipids. Importantly, the experimental approach we have developed opens up new possibilities in membrane biophysics, as it can be used to study other molecules embedded in the membrane.

References

Acknowledgement of financial support

This work was possible thanks to the financial support from the National Science Centre (Poland) grant no 2018/30/E/NZ1/00099

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Session Classification: Life Science & Digital Health