**“Bio” for membranes: perspectives and challenges**

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Biosystem membranes are particularly efficient in terms of selectivity, transport, catalytic, healing, self-cleaning, recognition, and sensing properties. Achieving such performance in the development of artificial membranes and much higher mechanical and chemical stability has attracted much attention in recent decades. Bio-inspired, bio-mimetic, bio-hybrid, bio-nic membranes became popular approaches. Although these terms are often used as synonyms, they refer to different approaches. Examples of the different case studies are discussed. Special attention is given to biohybrid membranes, to which our group has made a major contribution. Strategies explored to impart biological functions to manmade membranes via biomolecules immobilization and applications of the biohybrid membranes in various sectors will be discussed.

Despite the large number of studies in the literature, it remains a challenge to gain fundamental knowledge on how to predict and control biomacromolecule loading to preserve native biofunction and increase its stability, and how to avoid biomacromolecule deactivation during membrane cleaning and maintenance.

The main parameters related to macromolecules and membrane properties affecting the biohybrid membrane system are explained. The amount of the immobilized biomacromolecule, its distribution within the membrane support, the spherical topography of the nanostructured membrane, the physicochemical parameters at the microenvironment level (including surface energy and water activity), and mass transport seem to play a crucial role.

The potentialities of the biohybrid membranes in the production of bioactive molecules, bioremediation of recalcitrant micropollutants, biorecognition and biosensing will be described.

A brief hint on strategies to reversibly immobilize biomacromolecules on membranes, in order to remove them during membrane cleaning will be also presented.

Conclusions will outline drivers and brakes of the bio-hybrid membranes as well as future research directions to promote forefront achievements.

Acknowledgements

The Regione Calabria and EU are acknowledged for the financial support to the project SmartMatter within the framework of M-ERA.NET