Keynote

BIOLOGICAL FUNCTIONALIZATION OF SURFACES WITH S-LAYER PROTEIN LATTICES

Dietmar Pum, Bernhard Schuster, Nicola Ilk, Uwe B. Sleytr
Center for Nanobiotechnology, University of Natural Resources and Applied Life Sciences, Vienna, Austria
dietmar.pum@boku.ac.at

The study of biological self-assembly systems is a new and rapidly growing scientific and engineering field that crosses the boundaries of existing disciplines. The attractiveness of such bottom-up processes lies in their capability to build uniform, functional units or arrays and the possibility to exploit such structures at meso- and macroscopic scale for life and non-life science applications. In this context, monomolecular arrays of bacterial surface layer proteins (S-layer proteins) represent very versatile assembly systems for novel developments in medical applications of nanobiotechnology [1].

S-layers are the most commonly observed cell surface structures in prokaryotic organisms (bacteria and archaea) [1]. They are composed of a single protein or glycoprotein species (Mw = 40 to 200 kDa) and exhibit oblique, square or hexagonal lattice symmetry with unit cell dimensions in the range of 3 to 30 nm. Bacterial S-layers are generally 5 to 10 nm thick. They are highly porous protein meshwork with pores of uniform size and morphology in the range of 2 to 8 nm. One of the key features of isolated S-layer proteins is their intrinsic tendency to self-assemble into monomolecular arrays in suspension, at solid supports (e.g. silicon wafers), at the air-water interface, at planar lipid monolayers, at liposomes, and nanoparticles.

The lattice formation of S-layer proteins and the associated repetition of surface exposed functional groups and domains leads to highly uniform arrays where the properties of a single unit defines the characteristics of the whole assembly. On native S-layer protein lattices molecules and nanoparticles can be either bound by non-covalent bonds (e.g. electrostatic interactions) or by covalent bonds (e.g. binding *via* the amino groups after carbodiimide activation of carboxyl groups) (Fig.1a and b, respectively). Several different S-layer based biosensors were developed using these binding strategies. Nevertheless, a much more controlled and specific way of making highly ordered, nanopatterned affinity matrices is to use genetic approaches for the construction of S-layer fusion proteins (Fig.1c). In this way, diagnostic tools, vaccines, or biocompatible surfaces, as well as specific biomineralization strategies have already been developed [2].

The functionalization of surfaces by the reassembly of native or genetically engineered S-layer proteins is not only restricted to solid supports. While S-layer lattices which had reassembled on planar lipid membranes or on liposomes stabilize functionalized biomembranes, the S-layer by itself may be used to bind or address other molecules [2].

This presentation summarizes the basic principles and gives an outlook on possible medical applications of functionalized S-layer proteins.

References:

[1] Sleytr, U.B., C. Huber, D. Pum, B. Schuster, N. Ilk, E.M. Egelseer, FEMS Microbiol. Lett. **267** (2007) 131.

[2] Schuster, B., D. Pum, M. Sára, U.B. Sleytr. Mini-Rev. Med. Chem. **6** (2006) 909.

Figures:

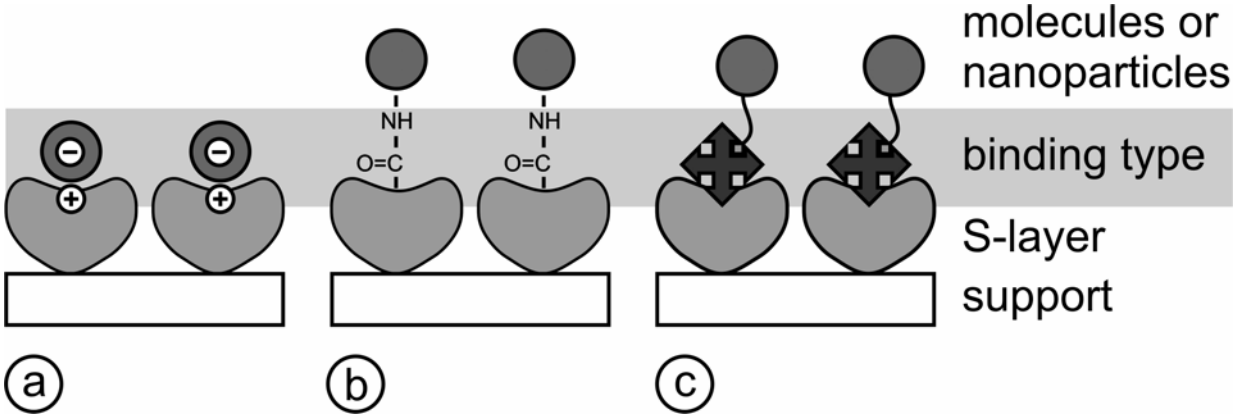

Figure 1. Schematic drawing of the different possibilities of binding molecules and nanoparticles on S-layers: (a) electrostatic binding, (b) covalent binding, and (c) using highly specific functional domains in S-layer fusion proteins.