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Unusual structure of aggregates formed by the fragment of Aβ(16-25) peptide

By the moment, a large number of proteins and peptides, polymerization of which in fibril formations leads to emergence of different diseases (amyloidosis), have been identified. But it is not always that fibril formations are toxic for organisms. A multitude of the so-called functional amyloids are known. Such amyloids have been found in many animals and plants as well in yeasts and bacteria. For several peptide and protein hormones, the functional state is their continued storage in secretary granules of the endocrine system (glucagon, somatostatin etc.). Many microorganisms have amyloid proteins on their cell surfaces. They help microorganisms not only interact with inert surfaces (plastic, glass) but also are required for adhesion to the host-cell surfaces. In this case, the risk of development of some diseases, such as tuberculosis, increases. Much attention has been recently focused on studying biofilms formed by amyloid proteins from microorganisms, for example, curlin from *E. coli*. Biofilms are intended for facilitating the adhesion of bacterial cells to the host-cell surface, which helps microorganisms to colonize host organisms. Lately it has been noticed that biofilms can be used as nanobiomaterials for studying different biological processes, for example, for enhancing retroviral transduction or direct visualization on the surface of nanofilms of viral particles. This is just the beginning of the usage of nanofilms. However their design could allow producing nanofilms with different programmed properties which is indisputably a promising range of research.

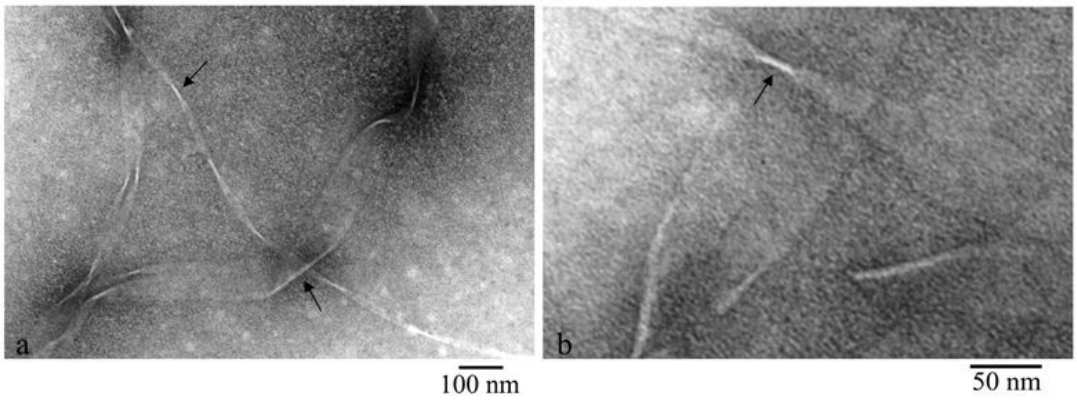

Fig. 1. Electron microscopic images of peptide Aβ(16-25) at large magnification. a, Polymer films of different width are seen in the field; b, Films are thin and nearly merge with the background. The film thickness in the places of their twisting is about 3 nm (arrows).

Our experience of studying different amyloidogenic proteins and peptides (insulin, Aβ(1-40) and Aβ(1-42) peptides including the different predicted amyloidogenic fragments of Aβ(1-42) peptide (Aβ(16-25), Aβ(31-40), Aβ(33-42)), and also the predicted amyloidogenic fragments of protein Bgl2p–glucantransferase from *S. cerevisiae* cell walls) has shown that the morphology of amyloid fibrils changes depending on the protein sequence. However, with the diversity of the objects studied, it is for the first time that we have observed polymers as films for the Aβ(16-25) peptide (Fig. 1). The process of amyloid formation for all investigated samples follows by the next pathway: destabilized monomer ® ring-like oligomer ® amyloid fibril. We have

found that the main building block of a fibril of any morphology is a ring oligomer (Fig. 2). Despite on the similar morphology of the general structural blocks upon amyloid formation the structure of oligomer is determined mainly by their amino acid sequence. The interaction of ring oligomers with each other in different ways in the peptides studied by us makes it possible to explain their polymorphism.

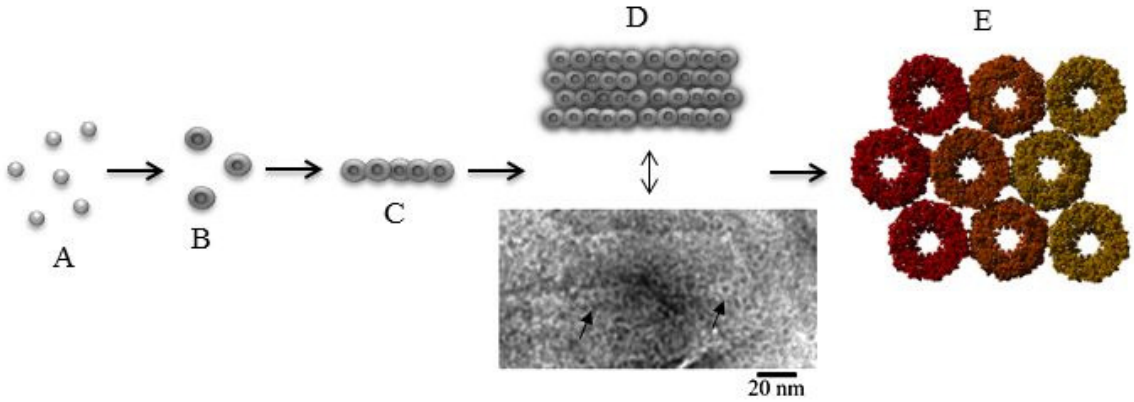

Fig. 2. Schematic representation of the process of nanofilm formation by the Aβ(16-25) fragment of Aβ. A – destabilized monomers; B – ring oligomers; C – short thin fibrils; D – films (on the enlarged image of the film fragment, the ring oligomers are indicated by arrows); E – molecular structure of nanofilm consisting of ring-like oligomer structures.

Nanofilms are of great interest for nanotechnology which is being intensely developed now. Biofilms open wide possibilities for studying biological, biochemical, and biophysical processes occurring in the organism at the molecular level. For example, they can be used as biosurfaces for fixing some short-lived intermediate processes upon interactions of proteins, protein complexes etc. The importance of methods of bioinformatics becomes obvious because they will make it possible to predict bionanomaterials with a priori determined properties. In the first place this concerns the production of differently charged nanofilms Due to their unique chemical and physical properties, amyloid nanomaterials have an inviting potential as a novel class of bionanomaterials. Nanostructures offer many potential applications from electronics to biologically active materials.

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Publication

Peptide Aβ(16-25) Forms Nanofilms in the Process of Its Aggregation.
Selivanova OM, Gorbunova EY, Mustaeva LG, Grigorashvili EI, Suvorina MY, Surin AK, Galzitskaya OV
Biochemistry (Mosc). 2016 Jul