XVI Congreso Nacional de Biotecnología y Bioingeniería
21 al 26 de Junio de 2015 Guadalajara, Jalisco, México.
Guadalajara

Engineering bacterial amyloids for biocatalysis and therapy

Antonio Villaverde
Institut de Biotecnologia i de Biomedicina and Departament de Genètica i de Microbiologia, Universitat Autònoma de Barcelona, Bellaterra, 08193 Barcelona, Spain; CIBER de Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Bellaterra, 08193 Barcelona, Spain
antoni.villaverde@uab.es

Key words: recombinant protein production, bacterial amyloids, nanomedicine, biomaterials

Bacterial inclusion bodies (IBs) have been traditionally considered by-products of protein production processes and regarded as exclusively formed by misfolded proteins [1]. However, a number of direct and indirect evidences have clearly determined that these protein clusters are formed by functional proteins and amyloid structures, combined in highly organized, biologically active protein particles [2-5]. Intriguingly, IBs show a relevant avidity for mammalian cell membranes and spontaneous cell penetrability in absence of toxicity. In this context, we have developed conceptual and methodological principles to explore and adapt IBs as self-organizing, mechanically stable and functional particulate materials [4] with applicability in biocatalysis [6], tissue engineering [7] and protein delivery [8]. In addition, relevant nanoscale properties of IBs are dramatically influenced by the activities of quality control of the producing cells and also by the conditions under which the recombinant protein is produced. Such versatility offers opportunities to adjust the performance of this promising biomaterial to specific applications through the engineering of both cell factory and process [9;10]. The recent demonstration of efficient IB production in endotoxin-free bacteria [11] offers a plethora of opportunities for use in biological interfaces, in the context of the emerging categories of nanostructured protein materials produced in microbial cells [12-14].

1. Baneyx F, Mujacic M: Recombinant protein folding and misfolding in Escherichia coli. Nat.Biotechnol 2004; 22: 1399-408
2. Carrio M, Gonzalez-Montalban N, Vera A, Villaverde A, Ventura S: Amyloid-like properties of bacterial inclusion bodies. J.Mol.Biol. 2005; 347: 1025-37
3. Ventura S, Villaverde A: Protein quality in bacterial inclusion bodies. Trends Biotechnol. 2006; 24: 179-85
4. Gonzalez-Montalban N, Garcia-Fruitos E, Villaverde A: Recombinant protein solubility-does more mean better? Nat.Biotechnol. 2007; 25: 718-20
5. Garcia-Fruitos E, Gonzalez-Montalban N, Morell M, Vera A, Ferraz RM, Aris A, Ventura S, Villaverde A: Aggregation as bacterial inclusion bodies does not imply inactivation of enzymes and fluorescent proteins. Microb.Cell Fact. 2005; 4: 27
6. Sans C, Garcia-Fruitos E, Ferraz RM, Gonzalez-Montalban N, Rinas U, Lopez-Santin J, Villaverde A, Alvaro G: Inclusion bodies of fuculose-1-phosphate aldolase as stable and reusable biocatalysts. Biotechnol Prog 2012; 28: 421-7
7. García-Fruitós E, Rodríguez-Carmona E, Díez-Gil C, Ferraz RM, Vázquez E, Corchero JL, Cano-Sarabia M, Ratera I, Ventosa N, Veciana J, Villaverde A: Surface Cell Growth Engineering Assisted by a Novel Bacterial Nanomaterial. Advanced Materials 2009; 21: 4249-53
8. Vazquez E, Corchero JL, Burgueno JF, Seras-Franzoso J, Kosoy A, Bosser R, Mendoza R, Martinez-Lainez JM, Rinas U, Fernandez E, Ruiz-Avila L, Garcia-Fruitos E, Villaverde A: Functional Inclusion Bodies Produced in Bacteria as Naturally Occurring Nanopills for Advanced Cell Therapies. Adv.Mater. 2012; 24: 1742-7
9. Garcia-Fruitos E, Vazquez E, Díez-Gil C, Corchero JL, Seras-Franzoso J, Ratera I, Veciana J, Villaverde A: Bacterial inclusion bodies: making gold from waste. Trends Biotechnol 2012; 30: 65-70
10. Villaverde A: Bacterial inclusion bodies: an emerging platform for drug delivery and cell therapy. Nanomedicine.(Lond) 2012; 7: 1277-9
11. Rueda F, Cano-Garrido O, Mamat U, Wilke K, Seras-Franzoso J, Garcia-Fruitos E, Villaverde A: Production of functional inclusion bodies in endotoxin-free Escherichia coli. Appl.Microbiol.Biotechnol. 2014; 98: 9229-38
12. Rodriguez-Carmona E, Villaverde A: Nanostructured bacterial materials for innovative medicines. Trends Microbiol. 2010; 18: 423-30
13. Villaverde A: Nanotechnology, bionanotechnology and microbial cell factories. Microb.Cell Fact. 2010; 9: 53
14. Vazquez E, Villaverde A: Microbial biofabrication for nanomedicine: biomaterials, nanoparticles and beyond. Nanomedicine (Lond) 2013; 8: 1895-8