Title: Influence of physical and chemical factors on evolution of cells
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Abstract

Nanotechnology plays a pivotal role in various fields, especially in bio- and medical-related branches of science, where a lot of effort has been made in the utilization of nanoparticles as a tool for early diagnosis, innovative drug delivery systems, tissue-engineered scaffolds, antimicrobial agents, etc. However, the primary focus of such research is concentrated on the investigation of the cytotoxic effect of nanoparticles on cells. So far, no data have been reported on the behavior of cells upon exposure to nanoparticles or any other physical stressor from a more broader - chemical, physical and biological perspective. The main goal of this work was to examine the mechanical stress induced by nanoparticles on living cells. This constitutes a major step towards the understanding of physical interaction between nanostructures and cells. This aspect is of importance to further combine nanotechnology with biological systems.

Chapter 1 provides a general overview of nanotechnology and nanoparticles in several aspects. It should be highlighted that comprehensive divisions of approaches used to obtain and characterize nanostructures, modes of interaction of nano-sized objects with cells were reviewed and prepared by the author based on literature. Importantly, interactions between cells and nanoparticles were also discussed.

Chapter 2 describes the influence of the shape of ZnO nanoparticles on different types of cells: bacterial, fungal and eukaryotic. Sharp ZnO nanorods appeared more damaging compared to rounded ZnO nanoparticles in the case of cells with a thin cell wall (Gram-negative bacteria) or soft membranes (cancer cell lines). In contrast, Gram-positive bacteria, which possess a thicker cell wall, appeared more resistant to mechanical stress induced by sharp nanorods.

Chapter 3 provides a broad overview of results collected to unveil phenotypic plasticity of Gram-negative bacteria that acquired mechanical resistance. Several experimental techniques were carefully chosen to reveal differences in viability, morphology and cell behavior of survivor bacteria.

Chapter 4 constitutes the first step toward better understanding the genetic origin of changes in bacteria exposed to ZnO nanorods. DNA sequencing was used to investigate the possible emergence of mutations, and RNA sequencing was employed to examine gene expression profile. Obtained results are discussed in the context of the acquisition of resistance against mechanical stress.

Chapter 5 as a continuation of genetic studies, provides a general overview of ongoing projects related to whole transcriptome analysis (RNA-seq) of bacteria during exposure to ZnO nanorods, and investigation of the mutation rate (DNA-seq).

Chapter 6 summarizes the finding presented in this thesis and provides the framework for future research in the field of bacterial adaptation to different, non-obvious factors. Important suggestions on the execution of possible applications are also included.