The development of antibiotics has played a significant role in combating the dreaded infectious disease. However, the improper use of antibiotics led to the development of multidrug resistance in microbial flora raising a global public health concern of 21st century. Bacteria, with their large populations and fast reproduction time, are able to rapidly develop mechanisms of antibiotic resistance when a subset of the bacteria population survives antibiotic exposure. This unforeseen threat demands the development of new drugs and strategies for combating antibiotic resistance shown by many microbial species. Recent developments in nanotechnology, engineering nanoparticles and nanocomposites with desired physicochemical properties, have been projected as a new line of defense against microorganisms. In recent years many researchers have tried to find out new antibacterial agents, as many microorganisms have acquired antibiotic resistance. In general, microorganisms acquire resistance to antibiotics during antibacterial therapy and other application fields and this property becomes inheritable. As a result of that process high-doses of antibiotics are used which are very toxic. Nanoparticles can be used as an alternative to antibiotics as there are a number of advantages. For instance, nanoparticles of metals with the size of 10 nm and less have high reactivity and can react with other substances practically without complementary energy. A share of surface atoms in nanoparticles is considerably greater than in bulk material and increases with reduction of particle size. Chemical bonds of nanoparticles surface atoms are not compensated and it results in appearance of new electrical, chemical, mechanical, toxic and other properties. Recently, it has been demonstrated that an new allotrope of carbon, graphene, has antibacterial activity. Also graphene-based nanocomposites have emerged as promising antibacterial materials. Nanocomposites can overcome the limitations of the individual components. For example, antibacterial nanomaterials attached to the graphene substrate are more stable and well dispersed.

The aim of this project is to study the interactions of graphene-based nanocomposites decorated with metal nanoparticles (Ag, Au, CuO, ZnO, Fe_3O_4) on selected microorganisms (*Staphylococcus aureus, Staphylococcus epidermidis*, *Escherichia coli*, *Salmonella enterica*, *Listeria monocytogenes*, *Pseudomonas aeruginosa, Streptococcus mutans, Bacillus subtilis*) through analysis of change in ion homeostasis, oxidative phosphorylation, ATPase activity and membrane integrity. On the basis of the available literature and preliminary studies we hypothesize that direct contact of the sharp edges of graphene nanowalls decorated with metal nanoparticles with bacterial membranes led to bacterial inactivation by mechanical damage of membrane, blocking respiration, electron transfer, oxidative phosphorylation In proposed project we want to characterize interactions of graphene-based nanocomposites decorated with metal nanoparticles (Au, Ag, CuO, ZnO, Fe_3O_4) and explain the mechanism of graphene-based nanocomposites toxicity by:

- analyzing the toxicity of graphene-based nanocomposites decorated with metal nanoparticles on selected bacteria (specific growth rate, viability assays)
- analyzing production of ATP and investigation of transport of H^+ and K^+ through the bacterial membrane
- analysis of biofim production
- analysis of reactive oxygen species (ROS) generation, DNA damage and lipids peroxidation
- evaluation of genetic response to oxidative stress
- evaluation of effect of graphene-based nanocomposites on external tissues of animal/human.