S STUDENTS

National Student Team Contest (first stage)
Solution of task 2. Surface-enhanced Raman spectroscopy in biomedical applications

1. The laser wavelength and the Raman scattering of the studied molecule should overlap the plasmon resonance of the nanostructure.

2. Nanostructures should be cell-friendly, e.g. they should not affect cell properties and at the same time they should be stable in physiological solutions. Nanostructures should be free of the synthesis by-products or by-products should be non-toxic for cells. Nanostructures should provide stable signal enhancement, meaning that in various experiments with the similar biological objects SERS spectra will be highly reproducible. Nanostructures should attach to the desired region inside or outside the cell to provide enhancement of Raman scattering of studied molecules.

3. Studies of cytochrome c in living mitochondria; submembrane Hb in erythrocytes, detection of bacteria in blood, evaluation of intracellular pH, amount of O_2^-, etc.

   First group: the main requirement is as in question 2. Additional requirenment: if these nanostructures' surface is modified by some molecules to attach the cell or some specific cell structure/molecule, the molecule-modifier should not give an enhanced Raman scattering itself.

   Second group: the molecule-probe, attached to the surface of nanostructure, should fulfill the following requirements: its Raman spectrum is (i) enhanced by nanostructures and (ii) depends on the surrounding property that is studied: pH, pCa, amount of reactive oxygen species, etc.

4. The delivery of nanoparticles to the cell cytoplasm usually occurs by the endicytosis. To increase the rate of endocytosis, it is possible to modify the nanoparticle surface with the specific peptide for intracellular localization. The second stage is to cause the release of the nanostructure from the lysosome to the cytoplasm, so, the nanostructure should have on its surface the peptide, which will cause the pore in the lysosome. And the last one, the nanostructure should have the signal of nuclear localization. Importantly, all these molecules should not give the SERS themselves and they should not interfere the enhancement of Raman scattering from the DNA or nuclear proteins.