S STUDENTS

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

During the last decades surface-enhanced Raman spectroscopy (SERS) became a popular technique in biomedical research, since it can provide an information about single molecules inside living cells. The idea about getting information from individual molecules in cells is highly attractive, because this can allow to monitor various cellular properties with high selectivity and sensitivity, to distinguish various cell states and to detect pathological changes in early stages. Briefly, in SERS Raman scattering is enhanced by many orders of magnitude if probed molecules are located near silver or gold nanostructures and if the excitation conditions match the plasmon resonance.

1. Specify, what are the basic requirements to nanostructures and to the excitation conditions to achieve SERS from the studied sample. **(1 point)**

For the successful SERS application in studies of living cells the key point are nanostructures, which properties should match various requirements.

2. What are the basic requirements to nanostructures to make them usable in cell studies? **(1 point)**

All SERS-active nanostructures, that are currently used in medicine and biology can be schematically divided into two groups: (1) nanostructures that are used for the enhancement of Raman scattering from the desired biological molecules; (2) nanostructures – specific probes, that consists of the nanostructure with the attached molecules, that provide information about surrounding properties, e.g.: pH, Ca^{2+} concentration, etc.

3. Give several examples of application of these two groups of nanostructures to study cell properties. **(1.5 points)** Specify and explain the requirements to the properties of nanostructures of both groups to make them applicable in serial biomedical studies. **(1.5 points)**

Imagine, that you need to study processes of DNA fragmentation in the cell nucleus. For this purpose you have to develop nanostructures that will be delivered to the nucleus. Nanostructure surface can be modified by any molecules you need to achieve the goal.

4. What should be the whole design of the nanostructure? How will you deliver the nanostructures into the cell cytoplasm? How should it be modified to enter the cell nucleus? **(3 points)**

Total – 8 points